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"Steve Wright" <swright@frontzdrilling.com>
Date: 12/18/2013 11:01:48 PM
Subject: RE: Bridgeton Landfill - West Lake Landfill: Core SamplingWork Plan (Phases 1B, 1C, and 2) and Core Sampling (Phases 1B,1C, and 2) Health and Safety Plan
Attachments: USEPA Cover Letter - Phase 1B 1C and 2 Work Plan Submitted 12-18-13.pdf
BT-012 Coring SamplingWork Plan - 12-18-13 - Final.pdf
Phase 1B -1C - 2 Core Sampling HSP 12-18-13.pdf

Good Evening,

On behalf of our client, Bridgeton Landfill, LLC, we hereby submit a revised version of the *Core Sampling Work Plan (Phases 1B, 1C, and 2)* and the *Core Sampling (Phases 1B, 1C, and 2) Health and Safety Plan.* Please note we have endeavored to address all 35 comments from your December 4th, 2013 letter within these two plans. We have our sonic driller on call for the week of January 6th, 2014. It is envisioned that the driller will mobilize early in that week, and then will undertake 1 day of GERT training, so drilling would most likely commence mid week. We will only commence operations after we receive written approval from the USEPA.

I look forward to continue to work with your staff, and your on scene coordinators. If you have any questions, please contact me.

Thank you,
Dan Feezor

Daniel R. Feezor, P.E.
Residuals Management Team Member
Feezor Engineering, Inc.
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Chatham, IL 62692
(217) 836-8842

December 18, 2013

Ms. Cecilia Tapia
Director
Superfund Division
United States Environmental Protection Agency
Region 7
11201 Renner Boulevard
Lenexa, Kansas 66219

RE: Bridgeton Landfill / OU-1 Coring (Phase 1B, 1C and 2) Investigation Work Plan and Health and Safety Plan

Dear Ms. Tapia:

On behalf of our client, Bridgeton Landfill, LLC (hereinafter Bridgeton Landfill), Feezor Engineering, Inc (FEI) hereby submits a revised version of the *Core Sampling Work Plan (Phases 1B, 1C, and 2)* and submits the *Core Sampling (Phases 1B, 1C, and 2)* H*ealth and Safety Plan.* This submittal is consistent with the United States Environmental Protection Agency's (USEPA) September 20, 2013, letter directing the investigation under the Additional Work provision of the Administrative Order on Consent for the West Lake OU-1 Superfund Site.

The *Core Sampling Work Plan (Phases 1B, 1C, and 2)* was revised based upon comments received by the USEPA on December 4th, 2013 and subsequent December 6th, 2013 conference call and December 12, 2013 meeting between Bridgeton Landfill, LLC and USEPA Region 7. Responses contained in the attached comment response and the *Core Sampling Work Plan (Phases 1B, 1C, and 2)* were prepared under the direction of a Missouri Professional Engineer (Daniel Feezor, P.E., MO P.E. Number E-30292). Technical contributors to these documents include P.J. Carey and Associates, P.C., Engineering Management Support, Inc., and Auxier and Associates, Inc.

Overview of Revised Work Plan

A Phase 1 GCPT investigation was recently conducted in the southern portion of Area 1. The purpose of the Phase 1 investigation was to provide initial field screening level data regarding the possible presence of RIM and to provide initial geotechnical data regarding subsurface conditions along potential alignments for the isolation/thermal barrier.

Results obtained by the Phase 1 investigation are still being evaluated; however, initial review of the field data indicated that RIM may be present beneath the southwestern portion of Area 1 beneath the anticipated western portion of possible alignments for the isolation/thermal barrier. Furthermore, some of the GCPT soundings in the eastern portion of Area 1 encountered refusal at depths shallower than anticipated; therefore, it is unclear whether these borings actually reached the base of refuse. Therefore, although originally it was anticipated that the next step in the investigation would be a Phase 2 investigation to obtain specific data along the proposed alignment of an isolation/thermal barrier, based on initial review of the Phase 1 results, it is clear that additional investigation is necessary in order to select an appropriate alignment for an isolation/thermal barrier.

The included Work Plan describes the scope and procedures to be employed for the next phase (Phase 1B) of the investigation. In the interest of providing an overview of all anticipated work and to potentially accelerate the overall review time and minimize downtime between the various phases of work, this work plan also describes the anticipated scope of expected subsequent phases of the investigation (e.g., Phase 1C and Phase 2 investigations).

A schedule has been included for all phases of the investigation. While we have tried to compress this schedule were possible, consistent with USEPA's request, the primary time driver is the analytical time necessary for the radiological tests. Radiological analytical tests must be held in the lab for a minimum of 21 days to obtain a defensible radium-226 measurement. With preparation time, internal review and assembly of the data reports, 4-6 weeks is a reasonable turn-around-time for the laboratory. Therefore, the schedule includes six weeks for laboratory analyses and two weeks for data validation for each phase. Bridgeton Landfill will work with the laboratory to reduce the time to the degree possible, but must allow for appropriate time in order to achieve the required Method Detection Activities. In addition, Bridgeton Landfill will continue to work with USEPA to optimize the schedule wherever possible.

Thank you again for your cooperation in this matter. We look forward to working with you. If you have any questions, please feel free to contact me at (217) 483-3118 or Bridgeton Landfill's Environmental Manager Brian Power at (314) 744-8165.

Sincerely,

Daniel R. Feezor, P.E.
Feezor Engineering, Inc.
dfeezor@feezorengineering.com

Attachment: Core Sampling (Phase 1B, 1C and 2) Work
Core Sampling Health and Safety Plan

Response to USEPA December 4, 2013, Comments

This attachment will respond to the 35 comments included with the USEPA December 4th, 2013 letter with the proposed work plan revision.

1. Section 1.1.1 — Site Conditions (first paragraph): The definition of radiologically-impacted material (RIM) described by the referenced 5 picocuries per gram (pCi/g) above background level should indicate that this level is for radium or thorium isotopes (with the exception of Thorium-230 and Thorium-232 which are combined), and that the RIM threshold for uranium is 50 pCi/g plus background as defined in the Supplemental Feasibility Study.

Response: Section 1.1.1 has been revised to reflect this comment.

2. Section 1.2 — Goals of the Investigation: The bulleted list of goals for the Core Sampling investigation should also include a bullet stating, "Waste characterization for disposal." Sufficient sampling will need to be conducted during the Phase II coring investigation in order to characterize the waste for proper disposal during trenching activities.

Response: A bullet was added to section 1.2.4 that chemical characterization will be conducted on Investigation Derived Wastes.

3. Section 4.1 - Overview of Technique (second paragraph): This section should state the Auxier Procedure 3.3, as referenced here, is included in Appendix B to this work plan (per Section 4.8.1).

Response: These revisions have been included but please note all the Auxier procedures have been included into a single appendix (Appendix A.)

4. Section 4.1- Overview of Technique (second paragraph): If methods other than sonic drilling are used, please explain how differences in bore diameters and collection techniques will be accounted for. One of the goals of the Phase II coring investigation is to determine type of waste/subsurface material which will be encountered during trenching (i.e. rock, municipal solid waste, construction

and demolition waste, etc.). A sufficient diameter core will be needed to accomplish this.

Response: It is not envisioned any other coring technique will be used other than the sonic technology. If any other technology is desired due to field circumstances, the on-scene coordinator will be consulted as stated in Section 4.3.1.

5. Section 4.3.1 — Boring Technique (fifth and sixth paragraphs): The terms “fluid” and “liquid” which are used to describe the water to be used during sonic drilling should be replaced with the term “potable water” for clarity. (See also Section 5.1.2.3 on waste/water management.)

Response: Section 4.3.1 has been modified to define liquid as potable water.

6. Section 4.3.2 - Other Techniques: If there is a possibility that some cores would be collected by a geoprobe instead of a sonic drilling rig, this work plan must describe the conditions that define when “…this technique can be used successfully…” and demonstrate that the core material retrieved by the geoprobe and the sonic drilling rig would be equivalent. (See comment 3 above for other drilling methods in Section 4.1.)

Response: Please refer to the response for comment 4.

7. Section 4.4 -Boring Locations: Develop selection criteria for the number of bore hole locations for Phase II, pending approval by the EPA. Emphasis should be based on the goals listed in Section 1.2, pertaining to waste characterization, along with barrier wall placement, and verification of non-RIM areas south of the barrier wall.

Response: The included Work Plan describes the scope and procedures to be employed for the next phase (Phase 1B) of the investigation. In the interest of providing an overview of all anticipated work and to potentially accelerate the overall review time and minimize downtime between the various phases of work, this work plan also describes the anticipated scope of expected subsequent phases of the investigation (e.g., Phase 1C and Phase 2 investigations). The location of proposed sonic borings (Phase 1B), and the location of additional GCPT soundings or sonic borings are depicted within Figure 3. However, the Phase 2 boring locations are still uncertain, since the barrier alignment is presently unknown. Proposed Phase 2 boring locations will be proposed through an addendum to this Work Plan.

8. Section 4.6 - Equipment Preparation and Safety Training: This section mentions a Phase II Health and Safety Plan (HASP), but this document was not provided to the EPA or MDNR. While the EPA and MDNR do not approve HASPs, this document must be provided with the final work plan, including descriptions of any air monitoring. Analytical data from air monitoring conducted for the purpose of worker protection (e.g., on-site worker air filters) will be made available to the EPA and MDNR.

   In addition, due to the coring of landfill material in areas where the GCPT logs indicated elevated gamma counts, a perimeter air monitoring program for the Phase II coring activities must be implemented. This air monitoring program must be in place and operational prior to beginning coring work. This program should be structured as described in the enclosure, and results provided to the EPA and MDNR as they are collected. Perimeter locations should be selected to be protective of the closest residential areas. The revised Phase II Work Plan must fully describe this air monitoring program.

Response: A new section 5 has been included in the *Core Sampling Work Plan (Phases 1B, 1C, and 2)* which details the new Health and Safety Monitoring System (air monitoring) consistent with discussions with USEPA. In addition, the *Core Sampling (Phases 1B, 1C, and 2) Health and Safety Plan* is being submitted with this correspondence.

9. Section 4.6 - Equipment Preparation and Safety Training (paragraph 2, last sentence): Describe what type of dust suppression will be used if dust is generated. Rework paragraph to include precautions that dust will not be generated (check 1st work plan for language).

Response: The sonic driller confirmed that using liquid for the drilling process will eliminate dust from the drilling operation.

10. Section 4.7 - Borehole Sampling (first paragraph): Planned locations for the core samples must not be unilaterally skipped; the EPA must be consulted to determine how to proceed. By building the road network to grades that could accommodate the gamma cone penetrometer (GCPT) vehicle, it is expected that the sonic drill rig will be able access all GCPT points. Any offset must be agreed upon by all parties to determine the best alternate location. Additionally, in the second paragraph, a brief discussion is needed on prevention of cross-contamination between boring locations and reference to the appropriate decontamination procedures, if necessary.

Response: This section has been revised to reflect that no planned boring / sounding will be skipped.

11. Section 4.8.1- Borehole Gamma Logging: The work plan must address how data from the one inch NaI gamma probe will be correlated with the results of the GCPT instrument and the data from the remedial investigation, as those logs were collected using different instruments. This will allow direct comparison of the new gamma log data with existing gamma log data.

Response: Direct correlations are not possible. However, similar trends in elevated counts at similar depths should be observable. The radionuclide analytical testing should provide more guidance once it is obtained.

12. Section 4.8.2 - Soil Core Gamma Scanning: It is not clear why the data from the soil core gamma scanning would be averaged, how averaging would be done or how results from voids in the core recovery would be handled. This section should explain these issues. Define FSPM in the footnote as the Field Sampling Procedural Manual which was developed by New Jersey and is used as a reference by others. Explain why the FSPM is applicable.

Response: Section 4.8.2 has been modified to provide more explanation regarding this procedure.

13. Section 4.9 - Soil Sampling: Remaining material from the soil core should not be placed back into the borehole. The borehole should be abandoned, consistent with Phase I, and the remaining material should be containerized for characterization and proper disposal. Also, the language should be clarified to indicate that two randomly spaced samples from each boring will be collected along with samples from each elevated gamma reading (i.e., a boring with two elevated gamma readings would be sampled in a total of four locations). Clarify the number of radiologic samples collected when readings are found, as stated in Section 4.8.2.

Response: The boreholes will be completed by installing PVC pipes over the drilling tool and these PVC pipes will be left in place. Therefore, no abandonment is needed**.** Section 4.9 has been modified to include a discussion about radiological sampling.

14. Section 4.9 — Soil Sampling (second paragraph): Please clarify how the used PVC sleeve will be handled; will it be decontaminated or disposed of as waste? In

addition, the EPA requests that Republic collect grab air samples from the head space of at least three boreholes and provide the sample results to the EPA and MDNR. The purpose is to use the open bore holes to sample the source gas in order to identify the appropriate non-radiological air sampling for the trenching operations. The source gas should be analyzed for aldehydes, ammonia, reduced sulfur compounds, S02, VOCs, carboxylic acids, CO2, methane and O2. Please identify which boring locations will be used to collect source gas samples in the revised Phase II Work Plan for review and approval.

Response: As stated in comment response number 13, the boreholes will be completed by installing PVC pipes over the drilling tool and completing these PVC pipes in place. Therefore, no abandonment is needed**.** No headspace gas readings are proposed at this time. The Addendum for Phase 2 work will address any air sampling appropriate for barrier construction planning.

15. Section 4.10 - Sample Handling and Shipping (second paragraph): On the list of label identifiers, include a bullet for units (e.g., inches). The last bullet contains a discrepancy between centimeters and inches to denote sample depths.

Response: Section 4.10 has been modified to reflect this comment.

16. Section 4.11- Sampling Processing (last paragraph): Clarify how the weight information will be used - to determine moisture content? If so, it should include both the wet weight and dry weight. Please cite the appropriate ASTM method.

Response: Section 4.11 has been modified to include the Oak Ridge Laboratory Quality Assurance Program Manual which describes the testing to be conducted (included in Appendix B).

17. Section 4.12 — This section should identify the specific radium, thorium and uranium isotopes to be analyzed, and must identify the actual analytical methods to be used. The language "…using industry standard methods *such as*…" is insufficiently specific. The analytical list and methods should be consistent with sampling performed during the Remedial Investigation.

Response: A new table 1 has been included in Section 4.9 which references the methods and the Method Detection Activity.

18. Section 4.12.3 - Analytical methods: In order to meet EPA's off-site disposal rule requirements, the receiving facility (e.g., Roxana, IL) will need a list of analytes

before receiving the waste. An asbestos analysis should also be added. Conduct a complete set of isotopic elements and non- rad testing as was performed for the Remedial Investigation (RI). Include the chemical analysis for waste characterization and worker safety.

Response: Please refer to the response for comment 2. For the Investigation Derived Wastes – any necessary analytical testing will be conducted as dictated by the licensed disposal facilities.

19. Section 4.7 - Borehole Sampling: Consider converting some of the borings to piezometers to collect groundwater information to assist in characterizing the site for construction (e.g., water management). Proper abandonment/replacement of monitoring well D-14 can be accomplished during this investigation.

Response: At this time, no piezometers are considered. It may be necessary along the east side if it is determined the existing GCPT data was not sufficient. If piezometers are necessary, an addendum to this work plan will be submitted. Monitoring Well D-14 is outside the scope of this investigation.

20. Section 5 - Contamination Surveys and Decontamination Procedures (general comment): Clarify the term "Permitted area" used in this section. Does it refer to the radiation work permit (RWP)? Use abbreviations as appropriate using this language.

Response: This is now Section 7, and the text has been modified to explain these "Permitted Areas".

21. Section 5.1.1.3 - Permitted Area Exit Survey - Equipment: Specify that scanning will be conducted for alpha, beta, and gamma activity (not just beta) with 44-9 probe. Clarify they are looking for removable contamination.

Response: This is now Section 7.1.1.3, and this section has been modified to address this comment.

22. Section 5.1.1.3 - Permitted Area Exit Survey - Equipment: Stay consistent with Phase I procedures regarding the frequency and sampling interval of wipe samples.

Response: This is now Section 7.1.1.3, and this section has been modified to address this comment.

23. Section 5.1.1.4 - Final Release Survey - Equipment, Table 2. pg 20: Provide more description concerning the relationship of the information contained in each column (i.e., limit column versus meter reading column). Make a reference that values were calculated from Appendix D, Procedure 2.3. Clarify meter reading with typical readings.

Response: This is now Section 7.1.1.4, and this section has been modified to address this comment. A reference to default efficiencies published by Ludlum Instruments has also been included.

24. Section 5.1.1.4 - Final Release Survey - Equipment, Table 2. pg 20: Reference the sources of information contained in Table 2.

Response: This is now Section 7.1.1.4, and this section has been modified to address this comment.

25. Section 5.1.2.1 — Dry Decontamination: Change this language to read "going from one 'boring location' to another," not "from one 'permitted area' to another 'permitted area"'.

Response: This is now Section 7.1.2.1, and this section has been modified to address this comment. As was done in the Phase 1 GCPT Project, the tool string was surveyed for radioactive contamination and decontaminated, if needed, between each sounding location. Similarly, in this Phase, the drill rig tool string will be surveyed for radiation and decontaminated as appropriate between boring locations.

26. Section 5.1.2.1 — Dry Decontamination: Use of the verb "attempt" is not appropriate. If the Table 2 limit is exceeded, either decontaminate the equipment or take it out of service.

Response: This is now Section 7.1.2.1, and this section has been modified to address this comment.

27. Section 6 —Reporting (paragraph 1): Clarify if separate reports will be written for Phase I and Phase II.

Response: This is now Section 9, and this section has been modified to state that there will be one stand alone report.

28. Section 6 - Reporting (paragraph 2): Include field data as an appendix (e.g., soil logs, soil screening, etc.). This appendix could be submitted in an electronic format.

Response: This is now Section 9, and this section has been modified to include what will be in the final report.

29. Section 7 — Anticipated Project Schedule: The EPA expects that the PRPs will look for and take advantage of any opportunities to accelerate this schedule, including doing tasks in parallel where possible.

Response: This is now Section 9, and the schedule has been included as Figure 4.

30. Appendices - Ensure all references are provided in the report. (e.g., quality assurance is referred to in Table 1. Analytical Methods/Quality Assurance Table, but a Quality Assurance Project Plan (QAPP) is not included).

Response: A new Section 8 – Quality Assurance has been added to address this comment.

31. Procedure 2.1, Section 3.2.2.7 - background: Include site-specific background response levels and location as a third column.

Response: Auxier and Associates, Inc. modified their procedures to address this comment.

32. Procedure 3.3, general - Add a procedure to address non-radiological sampling.

Response: Please see the response for comment #2.

33. Procedure 3.3, Section 4.3 - Update the procedure to indicate the sample is taken from the core itself, not from within the bore hole.

Response: Auxier and Associates, Inc. modified their procedures to address this comment.

34. Procedure 3.3. Section 4.4.3 — Update to reflect sonic drilling. Be aware sonic drilling may produce heat which could result in VOCs. The sample may volatilize out.

Response: No VOC analyses are proposed for the analytical testing so this comment is not relevant to the radiological testing program.

35. Figure 3 - Proposed Investigation - Update the map to include the latest GCPT results/data.

Response: Please see the Figure 2 within the Work Plan which summarizes the GCPT findings.

ENGINEERING FOR A BETTER WORLD
FEEZOR
ENGINEERING, INC.

BRIDGETON LANDFILL—WEST LAKE LANDFILL

CORE SAMPLING (PHASE 1B, 1C, and 2)
WORK PLAN

BRIDGETON, ST. LOUIS COUNTY, MISSOURI

STATE OF MISSOURI
DANIEL RICHARD FEEZOR
NUMBER PE-030292
PROFESSIONAL ENGINEER

Daniel R. Feezor
12-18-13

Prepared For:
Bridgeton Landfill, LLC
13570 St. Charles Rock Road
Bridgeton, MO 63044

December 18, 2013

Project No.: BT-012

Prepared By:

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Core Sampling Work Plan
(Phases 1B, 1C and 2)
Bridgeton Landfill, LLC

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1 INTRODUCTION

This document prescribes the location, technology, and methodology to be used to obtain the data necessary to identify a proposed alignment and develop design information for an isolation/thermal barrier. Installation of an isolation/thermal barrier would prevent migration of a subsurface smoldering event (SSE), if one were to ever occur, within Bridgeton Landfill's North Quarry Area into the adjacent Radiological Area 1 of the West Lake Landfill Superfund site.

Bridgeton Landfill is located within an area that contains the permitted Bridgeton Landfill sanitary landfills (the North and South Quarry Landfills) as well as historic West Lake Landfill (pre-regulation and pre-permitting) sanitary and construction and demolition landfills. Of particular note are two portions of the West Lake Landfill, identified as Areas 1 and 2 where in 1973, soil mixed with leached barium sulfate residue was placed as daily or intermediate cover material over and within solid waste disposed in these areas. The resultant mixture of solid waste mixed with soil containing leached barium sulfate residue is termed radiologically-impacted material or simply RIM. Areas 1 and 2 have been identified by the Environmental Protection Agency (EPA) as Operable Unit 1 of the West Lake Landfill Superfund Site. Remedial actions to address the RIM occurrences within Area 1 and 2 are being directed by EPA (EPA - 2008 and EMSI, 2011).

A SSE is occurring at depth within the South Quarry Landfill. Bridgeton Landfill, LLC has implemented measures such as installation of an ethylene vinyl alcohol cap, installation of additional landfill gas extraction wells, installation and monitoring of temperature probes, and other activities to address the occurrence of an SSE in the South Quarry Landfill. Bridgeton Landfill, LLC is also evaluating potential options for construction of an isolation/thermal barrier to be installed between the North Quarry Landfill and the adjacent Area 1. Bridgeton Landfill, LLC is evaluating these measures as a means to ensure that in the unlikely event that the SSE in the South Quarry Landfill were to spread to, or otherwise occur within the North Quarry Landfill, it could not expand into Area 1.

Prior investigations (RMC, 1982; NRC, 1988; McLaren/Hart, 1996a; and EMSI, 2000 and 2011) provided data that were used to estimate the extent of RIM in Area 1. Data obtained by these investigations indicate that the RIM was present beneath the northern portion of Area 1 and did not extend to the southern portion of Area 1, near the boundary with the adjacent North Quarry Landfill. Bridgeton Landfill, LLC previously determined that placement of an isolation/thermal barrier within Area 1, but outside of the extent of RIM, would be the optimal location for such a barrier. Placement of the isolation/thermal barrier within the southern portion of Area 1 would minimize the depth to which the isolation/thermal barrier would need to be constructed and minimize the amount of refuse that would otherwise need to be excavated and therefore result in reduced time, cost and potential impacts associated with construction of the isolation/thermal barrier.

To this end, Bridgeton Landfill, LLC previously prepared and submitted a Gamma Cone Penetration Test Work Plan (FEI, 2013) to EPA and subject to EPA approval is in the process of performing a detailed subsurface investigation in the southern portion of Area 1. The purpose of this investigation is to identify the optimum location and obtain geotechnical data for an isolation/thermal barrier to be located between Area 1 and the adjacent Bridgeton Landfill - North Quarry Area. This work is being conducted in accordance with EPA's September 20, 2013, letter directing the investigation under the Additional Work provision of the Administrative Order on Consent for the West Lake OU-1 Superfund Site.

A Phase 1 GCPT investigation was recently conducted in the southern portion of Area 1 (FEI, 2013). The purpose of the Phase 1 investigation was to provide initial field screening level data regarding the possible presence of RIM and to provide initial geotechnical data regarding subsurface conditions along potential alignments for the isolation/thermal barrier. A description of the Phase 1 investigation is provided later in this work plan. Results obtained by the Phase 1 investigation are still being evaluated; however, initial review of the field data indicated that RIM may be present beneath the southwestern portion of Area 1 beneath the anticipated western portion of possible alignments for the isolation/thermal barrier. Furthermore, some of the GCPT soundings in the eastern portion of Area 1 encountered refusal at depths shallower than anticipated and therefore it is unclear whether these borings actually reached the base of refuse. Therefore, although originally it was anticipated that the next step in the investigation would be a Phase 2 investigation to obtain specific data along the proposed alignment of an isolation/thermal barrier, based on initial review of the Phase 1 results, it is clear that additional investigation is necessary in order to select an appropriate alignment for an isolation/thermal barrier.

This Work Plan describes the scope and procedures to be employed for the next phase (Phase 1B) of the investigation. In the interest of providing an overview of all anticipated work and to potentially accelerate the overall review time and minimize downtime between the various phases of work, this work plan also describes the anticipated scope of expected subsequent phases of the investigation (e.g., Phase 1C and Phase 2 investigations).

1.1 Project Approach

1.1.1 Site Conditions

In the 1970's West Lake Landfill received various solid and industrial wastes, including soil mixed with leached barium sulfate residues containing traces of uranium, thorium and their long-lived daughter products. The presence of the RIM resulted in the West Lake Landfill being designated as a Superfund site. The RIM is located in two areas at the site: Area 1, which is adjacent to the North Quarry Landfill and thus is pertinent to this investigation; and Area 2, which is located along the northern portion of the site. Area 2 is approximately 1,000 feet (at the closest) from the outer boundary of the North Quarry Area and is separated from it by a road and a closed demolition landfill (Figure 1). Collectively, these two areas have been designated as Operable Unit 1 for the Superfund investigation and remediation activities while the rest of the site was designated as Operable Unit 2.

The southern border of Area 1 is contiguous to the waste mass of Bridgeton Landfill, a quarry-fill landfill containing municipal waste. At the present time, Bridgeton Landfill is experiencing a SSE in its South Quarry Area. While the SSE is currently a significant distance from OU-1 Area 1, Bridgeton Landfill wishes to develop a response strategy to ensure that the SSE does not spread into the Area 1 RIM. Bridgeton Landfill, LLC has committed to constructing a subsurface isolation/thermal barrier located between Bridgeton Landfill's waste mass and the RIM located within West Lake OU-1 Area 1. As directed by EPA, this work will be conducted pursuant to an Administrative Agreement and Order on Consent with EPA.

For purposes of this Work Plan, and in accordance with previous determinations, direction and guidance from EPA (EPA, 1997, 1998, 2010 and 2013, and EMSI, 2011) RIM will refer to waste material containing radionuclides at levels above those deemed appropriate for unrestricted use. Specifically, RIM will include materials that contain combined radium-226 and radium-228 at levels greater than 5 pCi/g above background (e.g., 7.9 pCi/g); combined thorium-230 and thorium-232 at levels greater than 5 pCi/g above background (e.g., 7.9 pCi/g); and total uranium greater than 50 pCi/g plus background (e.g. 54.5 pCi/g) [EMSI, 2011].

1.1.2 Proposed Isolation/Thermal Barrier

Bridgeton Landfill has evaluated the possibility of an isolation/thermal barrier as a contingent action to prevent an SSE from advancing from the North Quarry Landfill into the RIM in West Lake OU-1 Area 1. Specifically, Bridgeton Landfill evaluated the excavation of waste to create an isolation/thermal barrier south of the southern limit of radiologically impacted material in Area 1. Such an approach would also limit the volume of waste excavation, consistent with concerns raised by the Lambert-St. Louis International Airport Authority. Finally the relative speed of construction, about three months, would allow such a system to be implemented quickly.

Conceptual evaluation of isolation/thermal barrier designs, reported in the March 29, 2013, letter to Ms. Fitch of the Missouri Department of Natural Resources (MDNR) from Craig Almanza, identified potential alignments along which the isolation/thermal barrier could be constructed. The conceptual evaluation also identified that the amount of material requiring excavation and the depth of such a barrier would be substantially lessened – along with all the negative impacts associated with waste excavation – if the isolation/thermal barrier alignment were moved toward the north. This would allow avoidance of the existing slopes of the North Quarry fill and would reduce the depth of excavation along the eastern portion of the alignment, where quarry activity followed by landfilling would require a much deeper excavation the farther south the isolation/thermal barrier is located.

It is envisioned that the isolation/thermal barrier would be excavated in the non-RIM portions of Area 1, and the purpose of the Phase 1 and Phase 2 Investigations is to identify the alignment for such a location. Alternative methods exist for installation of an isolation/thermal barrier including slurry placement of barrier materials, installation of heat removal/cooling systems, or other techniques. Detailed construction plans for the Isolation/thermal barrier would be submitted for EPA review following conclusion of the investigation work directed by EPA's September 20, 2013 letter (EPA, 2013a).

1.1.3 Overall Scope and Approach of the Investigation

In order to select an alignment and develop the design plans for the isolation/thermal barrier, additional subsurface data are needed for the area between the known extent of the RIM within West Lake OU-1 Area 1 and the Bridgeton Landfill - North Quarry Area. Phase 1 of the project used Cone Penetration Tests (CPTs) to determine the characteristics of the subsurface materials within proposed alignments of the isolation/thermal barrier and the southern edge of the Area 1 fence. The CPT device was also capable of measuring subsurface gamma counts which can increase the likelihood that the proposed isolation/thermal barrier can be constructed without encountering RIM. Regardless of the investigation results, radiological scanning will occur during excavation to construct the isolation/thermal barrier to ensure RIM is not being relocated.

Consistent with EPA direction, the Phase 1 Gamma Cone Penetration Test (GCPT) investigation was the first of what was initially envisioned as a two phased investigation to confirm the isolation/thermal barrier location. The Phase 1 GCPT investigation was to be used to identify a potential alignment and obtain initial geotechnical data for a potential isolation/thermal barrier and was to be followed by a Phase 2 investigation that would confirm the results obtained from the Phase 1 GCPT investigation and further verify the suitability of the proposed alignment. The assumption underlying this approach was that the initial phase (Phase 1 GCPT) of work would not encounter RIM beneath the area of the potential alignment of the isolation/thermal barrier.

Review of the results of the Phase 1 GCPT investigation indicated that RIM may be present beneath the southwestern portion of Area 1 in the area of possible preferred alignments for an isolation/thermal barrier. Elevated gamma readings were obtained from depth intervals of approximately 25 to 35 feet (ft) below ground surface (bgs) in ten (10) of the GCPT soundings drilled in the southwestern portion of Area 1. Specifically, elevated gamma counts were reported in GCPT soundings 1.2, 2.2, 2.3, 3.1, 4.1, 4.2, 5.1, 5.2, 5.3, and 6.3 (Figure 2). The occurrence of RIM in this area was previously unknown as this area falls between approximately seven (7) of the soil borings drilled, downhole-gamma-logged, sampled, and tested for radionuclide occurrences in conjunction with performance of the Remedial Investigation for OU-1 (EMSI, 2000). Furthermore, the depths at which these materials were encountered (e.g., 25 – 35 ft bgs) were sufficiently great that the overlying solid waste provided sufficient shielding such that these materials were not identified by the overland gamma surveys conducted by the NRC (RMC, 1982) or in conjunction with the RI work (McLaren Hart, 1996b) or by the aerial survey recently conducted by EPA (EPA, 2013b).

Because initial evaluation of the results of the Phase 1 GCPT investigation suggest that RIM may be present beneath the southwestern portion of Area 1, additional investigations prior to identification of a potential alignment for an isolation/thermal barrier are needed. Borehole drilling and collection and laboratory analyses of soil/waste samples from this area are necessary to obtain information regarding the nature of the waste materials associated with the Phase 1 GCPT elevated gamma readings and to verify that the elevated gamma levels reported in borings drilled in the southwestern portion of Area 1 reflect the presence of RIM (in contrast to the possible presence of some other material) in this area. In addition, as previously indicated, many of the GCPT soundings drilled in the southeastern portion of Area 1 (e.g., GCPT soundings along alignments 13, 14 and portions of 15 – see Figure 2) encountered refusal at shallow depths.

Consequently, an additional phase (Phase 1B) of investigation is proposed prior to identification of a potential alignment for an isolation/thermal barrier. Phase 1B work would include drilling of additional borings, downhole gamma logging in the borings, and sampling the material responsible for the elevated gamma readings observed in the Phase 1 GCPT borings drilled in the area. Assessing why many of the GCPT soundings drilled during Phase 1 along the east side of the southern portion of Area 1 encountered refusal at shallow depths would also be conducted during Phase 1B. Assuming the material responsible for the elevated gamma readings in the southwestern portion of Area 1 is RIM, a subsequent phase of investigation (Phase 1C) is also envisioned to define the limits of this RIM prior to selection of an alignment for an isolation/thermal barrier. A Phase 2 core sampling investigation would confirm the characteristics (concentrations of isotopic elements, geotechnical data, and nature of fill materials) of the subsurface material along the proposed isolation/thermal barrier alignment.

This Work Plan, along with a corresponding Health and Safety Plan (HASP), is being submitted to detail the locations and procedures to be used to drill soil borings, collect core samples, and perform radioisotope analyses of selected core samples during the Phase 1B investigation. The procedures described in this plan and the previous GCPT Work Plan (FEI, 2013) are also appropriate for work anticipated to be performed as part of the Phase 1C and Phase 2 investigations.

1.2 Goals of the Investigation

The goals and objectives and overall scope of the various phases of the investigation are described below. To minimize delay between the various phases of the investigations, the EPA has requested an expedited development of a Work Plan that addresses the additional Phase 1 investigations and the Phase 2 investigation. At the time this work plan is being authored, the results of the Phase 1 GCPT work are still being evaluated. Therefore, this work plan is focused on the scope and procedures to be utilized to conduct the Phase 1B investigation. In order to expedite performance of the subsequent investigations, this work plan also describes the general scope and anticipated approach envisioned for the subsequent phases of the investigation. The procedures and protocols described in this work plan and the previous Phase 1 GCPT work plan (FEI, 2013) will also be used for the subsequent Phase 1C and Phase 2 investigations. The actual boring locations, drilling techniques (whether GCPT or soil/waste coring) to be used in the subsequent investigations have not been finalized at this time. Addenda to this work plan will be developed to describe the specific drilling locations, drilling and sampling techniques, and other aspects of the Phase 1C and Phase 2 work based on the results of the Phase 1 GCPT and Phase 1B investigations. These addenda will be submitted to EPA once the specific drilling locations and methodologies have been selected for the subsequent phases of work. It is the intention of Bridgeton Landfill, LLC and EPA to expedite the development and approval of these amendments so as to maximize the potential for continuous, uninterrupted investigation and design of an isolation/thermal barrier to the extent possible.

1.2.1 Phase 1 GCPT

Phase 1 of the investigation was focused on collection of information south of and, in some locations, up to the projected extent of RIM material occurrences, in order to confirm the absence of RIM in the location selected for the potential isolation/thermal barrier alignment. The goals of the Phase 1 investigation were to provide confirmatory observations that material within the proposed excavation area for the potential isolation/thermal barrier alignment does not contain RIM and to gather the required geotechnical data for design of the barrier.

The primary goals of the GCPT investigation (Phase 1) were to:

- Determine the stratigraphy, nature, and geotechnical properties of subsurface materials for design purposes,
- Determine liquid levels,
- Determine if any RIM exists within the potential isolation/thermal barrier excavation footprint,
- Determine depth to native material, and
- Use the above information to select the best alignment for the isolation/thermal barrier (proposed alignment).

1.2.2 Phase 1B – Completion/Confirmation Investigation

Initial review of the results of the Phase 1 investigation indicates that previously unidentified RIM may be present beneath the southwestern portion of Area 1. Specifically, elevated gamma readings were measured in GCPT soundings drilled in the southwestern portion of Area 1. One of the goals of the Phase 1B investigation is to obtain samples for laboratory analyses of the eight known isotopes associated with the RIM in OU-1. Therefore, Phase 1B will include drilling of soil borings, performance of downhole gamma logging of the soil borings, collection of samples of the specific material responsible for the elevated gamma readings observed in the Phase 1 GCPT soundings drilled in this area, visual inspection and description of the material associated with the elevated gamma readings, and submission of samples to an offsite analytical laboratory for radioisotope analyses.

Furthermore, many of the GCPT soundings drilled along the east side of the southern portion of Area 1 (e.g., those included in alignments 13 and 14 – see Figure 2) encountered refusal at shallow depths. The cause of this refusal could not be determined from the GCPT work. It may be due to the presence of construction and demolition debris in this area or alternatively may reflect the presence of shallow bedrock in this area. Data regarding the base of the OU-1 landfill wastes are needed in this area. Therefore, additional drilling is required to evaluate the nature of the materials responsible for GCPT refusal in this area and to verify the absence of RIM as well as obtain geotechnical data necessary for selection of a potential alignment for an isolation/thermal barrier through this area (i.e., to complete the objectives of Phase 1). Therefore, several soil borings will be drilled in this area using a drilling method that should be capable of drilling through any construction and demolition debris or the upper portion of any bedrock that may be present in this area to ensure that drilling extends through the entire thickness of refuse in this area.

It also necessary to obtain laboratory analytical data from known, unimpacted boring locations to assist with determination of background gamma levels and radioisotope activities associated with non-RIM waste and in situ soils. Therefore, soil/waste samples will be obtained from Phase 1B borings drilled in the eastern portion of Area 1 that do not display elevated downhole gamma readings. Samples will also be obtained from any borings/depth intervals where elevated gamma readings are encountered in the boreholes drilled in the eastern portion of Area 1.

1.2.3 Phase 1C – Delineation of the Extent of RIM

In order to select a proposed alignment for an isolation/thermal barrier, additional characterization of the area of elevated gamma readings in the southwestern portion of Area 1 will likely need to be performed, presuming that the results of the Phase 1B investigation indicate that these readings reflect the presence of RIM in this area. Although the logical approach for such an investigation would be to perform additional GCPT soundings outside of this area, use of the GCPT drilling technique may not ensure complete delineation of the extent of elevated gamma readings in this area. Besides the potential for refusal at depths less than the full depth of refuse as encountered in the eastern portion of Area 1, drilling to define the extent of RIM may necessitate drilling along and through the slope of the North Quarry Landfill, the waste deposits of which overlap the southernmost portion of Area 1. The depth of drilling required in this area could potentially exceed the maximum effective depth of the GCPT drilling rig (approximately 70 to 100 ft). Therefore, delineation of the extent of possible RIM in the southwestern portion of Area 1 may require performance of sonic drilling or a combination of

GCPT and sonic drilling. The proposed approach for completion of this delineation will be addressed in an addendum to this Workplan.

1.2.4 Phase 2 Core Sampling Investigation

The objective of Phase 2 of this project is to collect soil core samples from a limited number of locations and analyze the samples for the presence or absence of RIM as well as to confirm the characteristics of the subsurface material along the proposed isolation/thermal barrier alignment determined from the GCPT. The Phase 2 investigation will also be used as a verification of the GCPT methodology and interpretations for the geotechnical data.

Based on the results of the Phase 1 investigations, an initial conceptual design for an isolation/thermal barrier will be developed. The initial conceptual design will include a summary and evaluation of the Phase 1 investigation results, a proposed alignment for the isolation/thermal barrier, the anticipated barrier technology, and the general approach anticipated to be used for installation of the barrier. Based on the initial conceptual design, additional data necessary for finalization of the proposed alignment, isolation/thermal barrier design and construction techniques will be identified. Currently it is anticipated that the isolation/thermal barrier will be installed by excavation of refuse followed by placement of an earthen barrier along the north side of the excavation, followed by backfilling of the remainder of the excavation with refuse removed from other portions of the excavation. Upon completion, the EVOH cap being installed over the North Quarry Landfill will be extended over the isolation/thermal barrier and excavation areas.

Assuming the isolation/thermal barrier is constructed by excavation of existing refuse, the primary goal of the Phase 2 core sampling investigation will be to quantify subsurface concentrations of isotopic elements within the isolation/thermal barrier construction area. This will involve:

- Installation of a sufficient number of boreholes to verify the GCPT data within the isolation/thermal barrier excavation limits~~;~~
- Produce geophysical and radiometric logging data from each soil core;
- Collect samples of soil materials from each length of the borehole (minimum 2 per borehole);
- Generate downhole gamma logs that will be used to prioritize sample analysis from the borehole samples collected;
- Submit soil samples to a certified, independent laboratory for radioanalyses;
- Determine type of waste/subsurface material (e.g., rock, municipal solid waste, construction and demolition waste); and
- Determine the necessary chemical analyses of the Investigation Derived Wastes, so that the soil cores may be properly disposed after all analytical testing has concluded.

The design process will use the results of the Phase 1 investigations to conceptually design the isolation/thermal barrier. Data such as depth of waste, liquid levels, width of isolation/thermal barrier, allowable slopes, and staging requirements will be used in the alignment and “daylight” line projections, which will guide the coring location selection.

2 PREVIOUS INVESTIGATIONS

Previous investigations in the vicinity of a potential alignment for a subsurface isolation/thermal barrier between Area 1 and the Bridgeton Landfill North Quarry Area did not contemplate construction of a physical structure; therefore, geotechnical data necessary to design a barrier does not exist. However, previous investigations have identified the presence of RIM in Area 1 of the West Lake Landfill using downhole gamma radiation logging of soil borings, collection and analyses of surface and subsurface soil samples, and overland gamma surveys.

2.1 PRIOR INVESTIGATION METHODS

Downhole gamma radiation logging and overland gamma surveys were used as the primary RIM detection methods for these investigations. In addition, samples were collected from soil borings for analyses of uranium, radium, thorium isotopes and their decay products as well as for non-radiological constituents. Results of these investigations are presented in the Soil Boring/Surface Sample Investigation Report (McLaren/Hart, 1996a) and the OU-1 Remedial Investigation Report (EMSI, 2000). Eight radionuclides were identified as contaminants of concern based on their long half-lives: Uranium-238, Uranium-234, Thorium-230, Radium-226 and Lead-210 from the Uranium-238 decay series; Uranium-235 and Protactinium-231 from the Uranium-235 decay series, as well as Thorium-232 and its progeny. Isotopes from the Thorium-232 decay series are also present at levels above background, although to a lesser extent.

2.2 RESULTS OF PREVIOUS INVESTIGATIONS IN AREA 1

Downhole gamma logging by McLaren/Hart in Area 1 found elevated radiation levels varying from zero to sixteen feet bgs, while the thickness of the materials generally ranged from one to five feet in Area 1. In the northwest region of Area 1, elevated readings ranged from zero to six feet bgs, while to the southeast, elevated readings were found as deep as 15 feet bgs. The estimated extent of the impacted area is illustrated in Figure 2.

An overland gamma survey (McLaren/Hart, 1996b) also detected gamma radiation above background at the ground surface. Laboratory analyses of surface soil samples (the upper 6 inches) detected radionuclides at levels above 5 pCi/g above background at boring locations WL-106 and WL-114.

The 2011 Supplemental Feasibility Study (SFS) [EMSI, 2011] included a detailed estimate of the extent of RIM in Area 1. An outline of the known impacted material was created using the available boring data, as well as an outline of the known non-impacted area (see SFS Appendix B-2, Figures 3 and 4). Based on these boundary conditions, the estimated limit of the RIM in

Area 1 was interpolated between these two boundaries. These boundaries, the interpolated RIM limits, and borings used to estimate the limits are shown in Figure 2 of this Work Plan.

The SFS delineation of the extent of RIM was sufficient for purposes of developing and evaluating potential remedial alternatives for OU-1. However, construction of the isolation/thermal barrier requires a high degree of confidence that the alignment for the isolation/thermal barrier is located outside of the extent of RIM. Therefore, as part of geotechnical investigation of the proposed alignment, data are also being obtained to confirm that the selected alignment is outside the location of RIM above levels for unrestricted use.

3 GCPT INVESTIGATION (PHASE 1)

The scope of the Phase 1 GCPT Investigation was detailed in the September 27, 2013, document entitled “Bridgeton Landfill – West Lake Landfill Gamma Cone Penetration Test (GCPT) Work Plan Revision 2” prepared by Feezor Engineering, Inc., P.J. Carey and Associates, Engineering Management Support, Inc., and Auxier and Associates, Inc. This work plan described the procedures and protocols to advance a piezocone sounding in an area between the known RIM area in Area 1 of OU-1, and the southern edge of OU-1 Area 1. During the investigation, data regarding the stratigraphy, nature, and geotechnical properties of the materials as well as liquid levels, as they relate to the design of a isolation/thermal barrier system were collected with each piezocone sounding. In the same CPT sounding, gamma radiation logging was performed using a proprietary device that is included in the equipment tool string behind the GCPT head. The device used a Cesium Iodide crystal. The device differs from a typical downhole logging gamma detector in that it is part of the push rod system and therefore has greater shielding from the thicker rod walls and is smaller in diameter for the same reason. However the device has been used successfully on other projects to detect the differences between clays and silts.

Tip force, sleeve force and pressure were all recorded as the push rods were advanced. Reading intervals were taken at intervals not exceeding 50 mm. The advance rate of the probe was approximately 2 cm/second, which is the American Society for Testing and Materials (ASTM) Standard.

The type of soils, including waste materials, was inferred based on the analysis of the combination of tip, sleeve and pore pressure while advancing (referred to as dynamic pore pressure). Work at other sites has demonstrated that interfaces between waste material and natural soil can be identified using CPT technology.

The activities described in the approved work plan involved conducting an overland gamma scan in the area between the known RIM area in Area 1 of OU-1 and the southern edge of OU-1 Area 1, clearing brush and vegetation to deploy a geotextile and stone to provide all-weather roadways for investigative equipment, advancing GCPT borings, and evaluating results. All equipment and personnel followed the radiological screening and safety protocols as discussed with the Phase 1 work plan and complementary HASP.

Initial results of the Phase I GCPT work are presented on Figure 2. Initial review of the results of the gamma logging of the GCPT soundings indicate that elevated gamma readings were present in some of the GCPT soundings drilled in the southwestern portion of Area 1 and to the west of the previous OU-1 western boundary. Borings with reported elevated downhole gamma readings include the following:

- GCPT 1.2

- GCPT 2.2
- GCPT 2.3
- GCPT 3.1
- GCPT 4.1
- GCPT 4.2
- GCPT 5.1
- GCPT 5.2
- GCPT 5.3
- GCPT 6.3
- GCPT 8.1 (possible)
- WL-119 (possible)

Subject to the results of the Phase 1B drilling program, additional drilling may be necessary to further delineate the extent of elevated gamma levels/RIM in this area.

Please note that the following soundings warrant additional investigation once the analytical data are obtained from the Phase 1B investigation, as the gamma counts pertain to the background level. These sounding include the following:

- GCPT 7.3
- GCPT 11.4
- GCPT 15.1
- GCPT 15.3

Also note that other GCPT soundings encountered elevated gamma counts which were not unexpected due to their proximity to known RIM boundaries. These include the following:

- GCPT 12.1
- GCPT 13.1
- GCPT 14.1
- PVC 25
- PVC-28
- PVC 36 (also called GCPT 6.1)

As previously discussed, a number of borings along the eastern side of Area 1 encountered refusal at shallow depths and therefore may not have reached the base of refuse. Borings that encountered shallow refusal include the following:

- GCPT 13.2
- GCPT 13.3
- GCPT 13.4
- GCPT 13.5
- GCPT 13.6

- GCPT 13.7
- GCPT 14.2
- GCPT 14.3
- GCPT 14.4
- GCPT 14.5
- GCPT 14.7
- GCPT 15.2
- GCPT 15.8 (Possible)
- GCPT 16.3 (Possible)
- GCPT 16.4 (Possible)
- GCPT 16.5 (Possible)
- GCPT 16.6 (Possible)
- GCPT 16.7 (Possible)
- GCPT 16.8 (Possible)

Additional drilling will be needed to assess the source of the refusal encountered in these borings (i.e., shallow bedrock, construction and demolition debris, other material) and to determine the depth of refuse in this area.

4 PROPOSED INVESTIGATIONS

4.1 OVERVIEW OF TECHNIQUE

As stated previously, the purpose of the GCPT investigation is to verify the absence of RIM in the area where excavation would be performed to construct an isolation/thermal barrier. The GCPT investigation will provide qualitative data regarding the presence and nature of the materials encountered and was not intended to be quantitative. After review of the initial data obtained from the GCPT investigation (Phase 1), the proposed location for the isolation/thermal barrier will be determined. Select locations within the area of potential excavation for construction of an isolation/thermal barrier will then be core drilled to a depth 10 feet below the waste materials. Samples will be collected for analytical testing for radiological isotopes and geotechnical property characterization.

The soil core samples will be collected using sonic drilling, GeoProbe drilling, or other available and appropriate technologies. Samples for radiochemistry analyses will be collected using Auxier & Associates Procedure 3.3 (included in **Appendix A**). The soil samples will be taken at various depth locations of the core boring sample subject to where soil materials are encountered in each boring. Biased samples will be taken at locations of radioactivity as identified by field radiation detection instruments. Other samples will also be taken where no radiation is detected by such radiation detection instruments.

4.2 LOCATION OF BOREHOLES

4.2.1 Phase 1B Investigation – Completion/Confirmation Investigation

As discussed above, soil borings, collection of core samples and submittal of laboratory samples are needed to further evaluate the reported elevated gamma values obtained during the Phase 1 GCPT investigation. In order to verify whether the elevated gamma readings obtained during Phase 1 represent RIM, samples must be obtained and submitted for laboratory analyses for radium, thorium and uranium isotopes. It is not necessary to collect samples from all ten of the locations with elevated gamma readings to verify whether the elevated gamma readings reflect occurrences of RIM. Collection of soil cores and samples from five of the ten GCPT soundings with elevated gamma readings is considered sufficient to verify whether the elevated gamma readings correspond with occurrences of RIM. Therefore, drilling and collection of soil cores are proposed to be performed at or adjacent to the following locations:

- GCPT 5.3 – the GCPT sounding with the reported highest gamma reading
- GCPT 2.2 – a GCPT sounding with an intermediate level gamma reading
- GCPT 1.2 – the westernmost GCPT sounding with an elevated gamma reading

- WL-119 – a GCPT sounding with a slightly elevated reading at 45.6 feet, in which analytical isotopes are needed to understand the elevated reading
- GCPT 8-1 – a GCPT sounding that had a slightly elevated reading at 29 feet, in which analytical isotopes are needed to understand the elevated reading

In addition, eight borings are proposed for the area where the GCPT soundings encountered refusal at shallow depths. The proposed locations and rationale are provided below:

- GCPT 12.5 – a southern location along path 12 to determine the elevation of the bedrock
- GCPT 13.3 – the northernmost location along line 13 where shallow refusal occurred
- GCPT 14.2 – the northernmost location along line 14 where shallow refusal occurred
- GCPT 14.4 – a location in the center portion of the area where shallow refusal occurred
- GCPT 14.7 – the southernmost location where shallow refusal occurred
- GCPT 15.2 – the only location along line 15 where shallow refusal occurred
- GCPT 16.3 – the northernmost location the potential isolation/thermal barrier alignment along Path 16
- GCPT 16.6 – a mid-path alignment check location of the bedrock elevation

If elevated gamma readings are not encountered in the first three of these borings, then a field decision may be made to substitute locations 13.4 and 14.3 in place of the two southernmost locations. Presuming that elevated gamma readings (laboratory analyses of the core samples) do not indicate the presence of RIM in the four northernmost locations and these two additional locations, a possible alignment for an isolation/thermal barrier could be selected to pass through the general area of these eight borings.

If elevated gamma readings are encountered in any one of the first three locations listed above, then a field decision could be made (in consultation with the on scene coordinator for the EPA) not to drill the remaining northernmost borings but instead to relocate to the next set of boring locations to the south (e.g., GCPT 13.4 and 14.3) and to add the two adjacent locations to the south (e.g., GCPT 13.5 and 14.4) to determine whether a more southerly alignment may be appropriate. It is anticipated that drilling would proceed in this area until at least two adjacent borings in each line are drilled without encountering elevated gamma levels.

4.2.2 Phase 1C Investigation – Delineation of the Extent of RIM

The eastern, northwestern, and southern extents of the elevated gamma occurrences in the southwestern portion of Area 1 can be delineated based on the results of the Phase 1 GCPT investigation and the results obtained during the RI investigation. Specifically, elevated downhole gamma readings were not encountered in GCPT soundings GCPT 6.2, 6.4, 6.5, and 7.2 located along the eastern margin of the area where elevated gamma readings were identified (Figure 2). Furthermore, neither elevated gamma readings nor radionuclide occurrences above those used to identify RIM were encountered in RI borings WL-107, WL-116 and WL-119

(McLaren Hart, 1996a and 1996b and EMSI, 2011). Therefore, the eastern extent of the area with elevated gamma readings has been defined (see Figure 2).

The northern extent of the area with elevated gamma readings (i.e., north of GCPT 3.1, 5.1, and 5.2) has not been defined. The occurrence of elevated gamma levels could extend from these borings to the north up to the area where RIM was previously identified as being present in the northwestern portion of Area 1 (e.g., in RI borings WL-105B, WL-102, WL-106B and NRC boring PVC-36) or the area of elevated gamma levels identified in the Phase 1 GCPT soundings may terminate before reaching the northern edge of the area previously identified as containing RIM (see the redline boundary shown on Figure 2). Regardless of which of these conditions exist, additional characterization to the north of the existing Phase 1 GCPT soundings is not needed for the isolation/thermal barrier evaluation, as the proposed location for the isolation/thermal barrier would be to the south of the area of the elevated gamma readings.

GCPT soundings 1.1 and 2.1 along with RI boring WL-124 define the northwestern extent of the area with elevated gamma readings. Downhole gamma logging of boring WL-124 did not detect elevated gamma readings or radionuclide activities above the unrestricted use levels; however, no soil was encountered in the waste materials in this area so the only sample obtained and submitted for laboratory analyses from this boring was obtained from the ground surface. Based on the combined results from the two GCPT soundings and the RI boring, additional drilling is not needed to delineate the northwestern extent of elevated gamma readings.

The western extent of elevated gamma readings, to the west of GCPT boring 1.2, has not been defined; however, there is only approximately 25 ft of open ground between GCPT sounding 1.2 and the existing transfer station building. Therefore, only one additional boring could potentially be drilled in this area (subject to inspection of the area and utility clearance to determine actual suitability for additional drilling). The existing soil boring array also does not define the extent of elevated gamma readings to the south of boring GCPT 1.2, so an additional boring may also be required in this area.

The overall southern extent of the area of elevated gamma readings can be generally defined by GCPT soundings 3.2, 5.4 (still need to investigate background levels for 5.4), 6.4 and 6.5 and RI borings WL-107, WL-121, WL-122 and WL-123 which did not detect elevated gamma readings or radionuclide activities above the unrestricted use levels (however, although elevated downhole gamma readings were not measured in borings WL-121, -122, and -123, soil was not encountered in the waste materials in these borings so the only samples obtained and submitted for laboratory analyses from these borings were collected from the ground surface). Significant separation does exist between some of the RI borings (e.g., between GCPT 4.2 and WL-122) so the exact limits of the elevated gamma readings in this area are not precisely known. Because this area may be represent a potential alignment for an isolation/thermal barrier, additional drilling in this area is recommended.

Tentative boring locations to further define the extent of the elevated gamma occurrences are provided on Figure 3. The exact number and location of additional soil borings to address this objective will be determined based on the results of the Phase 1B drilling, logging, and sampling activities in the area of the elevated gamma readings identified by the Phase 1 GCPT program.

4.2.3 Phase 2 Core Sampling Investigation

As previously discussed, additional data are required to determine an appropriate location and alignment for an isolation/thermal barrier. The specific alignment cannot be determined until evaluation of the Phase 1 GCPT investigation results is completed and the Phase 1B and 1C investigations have been performed. After completion of all Phase 1 investigations, a proposed alignment and conceptual design for an isolation/thermal barrier will be developed. Once the proposed alignment is determined, locations for Phase 2 borings can be identified. The specific number and locations of borings for the Phase 2 program will be determined based on the results of the Phase 1 GCPT, Phase 1B and Phase 1C investigations. It is anticipated that the proposed locations of the Phase 2 boreholes will be distributed at regular intervals along the proposed alignment. An addendum to this work plan will be prepared to present the locations of the Phase 2 borings.

4.3 Boring Techniques

4.3.1 Sonic Drilling

The MDNR suggested a coring procedure such as a sonic drilling within their August 20, 2013, letter to the Bridgeton Landfill, LLC. Therefore, the sonic drilling technique will be used to advance the borings and collect core samples. Other drilling methods may be considered if the sonic drilling technique encounters difficulties or otherwise poses problems. Such a modification would be made in consultation with the on-scene coordinator.

Sonic drilling conducted in accordance with ASTM D6914 will be used for the advancement of a continuous core for each borehole. ASTM D6914 provides guidance and discussion about this technique which is summarized in this section.

Sonic drilling is used for geo-environmental investigative programs. Sonic drilling offers the benefit of significantly reduced drill cuttings and reduced fluid production. Furthermore, sonic drilling does not entail the use of any drilling fluids such as air or water to circulate cuttings (water may be used to cool the downhole equipment) and therefore does not result in any form of emissions at the ground surface. The continuous core sample recovered by the sonic drilling technique provides a representative lithological column for review and analysis. The ability to cause vibration to the casing string eliminates the complication of backfill bridging common to other drilling methods and reduces the risk of casing lockup allowing for easy casing withdrawal during grouting.

The cutting action, as the sonic drilling bit passes through the formation, may cause disturbance to the soil structure along the borehole wall. The vibratory action of directing the sample into the sample barrel and then vibrating it back out can cause distortion of the specimen. Core samples will be hydraulically extracted from the sample barrel to reduce distortion. The use of split barrels, with or without liners, may improve the sample condition but may not completely remove the vibratory effect.

Some of the GCPT soundings were unable to be advanced due to large concrete construction and demolition debris fill encountered during the sounding. The sonic rig will be able to penetrate these fill materials. Sonic drilling through construction and demolition debris material may require the use of fluid (no air drilling allowed) to remove drill cuttings from the face of the bit, as they generally cannot be forced into the formation.

Some heat generation may occur within the borehole due to the use of sonic drilling. Liquid (potable water) will be injected down the drill string to reduce potential heat generation. Use of liquid will also increase core recovery. No liquid return to the top of the boring is anticipated.

4.3.2 Other Techniques

GCPT drilling may be used to further delineate the extent of elevated gamma readings in the southwestern portion of Area 1 (i.e., the Phase 1C investigation). A decision regarding the potential applicability of further GCPT drilling will be made based on the results of the Phase 1B investigation and may include comparison of the relative merits of GCPT and sonic drilling techniques. If additional GCPT drilling is determined to be suitable, the procedures for conducting such drilling will be the same as those used during the Phase 1 investigation as described in the prior Phase 1 work plan (FEI, 2013).

While it is not envisioned to be used for the Phase 1B, 1C and Phase 2 investigations, use of a Geoprobe® vibrating hammer may be attempted in areas where overlying construction and demolition debris is not suspected. If this technique can be used successfully, then both sonic drilling and Geoprobe® techniques may be used.

4.4 Site Preparations

The selected location for a given soil boring will be located and marked by a land surveyor before sampling will begin at that location. These locations will be surveyed, horizontally and vertically, using the local Site coordinate system and recorded.

4.5 Equipment Preparation and Safety Training

Equipment will be in proper working order and inspected to determine if it meets safety requirements per Auxier & Associates Procedure 2.1 in **Appendix A**. Personnel will be briefed on potential hazards including working around moving equipment, physical hazards, biota, and risks associated with radiological or chemical exposures. Health and Safety

Protocol/Procedures pertaining to general and radiological aspects of drilling in impacted areas are included in the HASP.

It is anticipated that all work will be completed in modified OSHA level D personal protective equipment (PPE), as required by the Auxier & Associates Radiation Safety Officer or his on-site designee (RSO). Respirators for protection from radionuclide exposure will not be routinely required but will be made available to workers. Respirators for protection from dust inhalation may be used if there are continuous plumes of visible dust from the borehole or soil cores; however this condition is not anticipated to occur. Application of water during drilling should alleviate this situation. A decision to require use of respirators may be made by the RSO if conditions are encountered that warrant use of respirators for protection from dust or radionuclides.

Survey instrumentation will be calibrated and documentation of calibration will be available for inspection. Sampling equipment and industrial hygiene monitoring equipment will be in proper working order and documentation of calibration (if applicable) will be available for inspection. A daily instrument response check will be performed on all radiological instruments used for quantitative measurements before the instruments are used. The results of these response checks will be recorded and retained for inspection.

4.6 Surface Radiation Measurements

Drill sites and access paths to drill sites will be surveyed by the RSO prior to entry or the start of any drilling activities. The RSO will conduct an overland gamma scan of the drill sites and access roads to the extent that such surveys were not previously performed in conjunction with the Phase 1 GCPT investigation. The same procedures used for the Phase 1 GCPT surveys will be used for any surveys performed in conjunction with the Phase 1B and 1C or Phase 2 work. These procedures were previously presented in the Phase 1 GCPT work plan (FEI, 2013); however, for completeness, the procedures to be used are included below.

For any areas without previous surface scans in the Phase 1 investigation, a Ludlum 2221 ratemeter/scaler mated to a Ludlum 44-20 3x3" NaI detector (or equivalent equipment) will be used to survey selected portions of ground surface within and around Area 1. This instrument will be coupled to a Trimble GPS and operated in the ratemeter mode. This mode will allow the gamma count rate from the instrument to be collected at one-second intervals and assigned to its specific measurement location (latitude and longitude). The operator will hold the detector approximately 30 cm above the ground surface and advance across the areas of interest in a series of straight lines at a rate of approximately one meter per second. The separation distance between the lines will be approximately 1.5 meters. After the survey, the field data will be processed using a combination of industry standard commercial computer applications. Because all data points will be tied to a spatial coordinate, a map of the data will identify areas of surface soil containing RIM. These areas can then be located in the field and avoided or covered. If the overland gamma scan indicates a radiological level over background, the RSO will notify the clearing crew that they could be in an area that has surface RIM and to proceed in a manner that avoids ground disturbance. The path to each borehole location will be cleared of vegetation 10-20 feet wide in the general direction dictated by the onsite surveyor. The cleared path and the path to be cleared (as much as practicable) will be scanned with the overland gamma scanning equipment; then the next section will be cleared. This procedure will be used in the same sequence until the desired borehole location has been reached. It is envisioned that paths to each borehole location will be approximately 10-15 feet wide, while a larger area (25-30 feet diameter) will be cleared at each borehole location.

Exposure and dose rates will be measured over each borehole location before drilling starts. In addition, thermoluminesent dosimeters (TLDs) or equivalent will be installed 1-meter above a minimum of three (3) marked boreholes. These TLDs will be collected after 10 weeks or before isolation/thermal barrier installation, whichever is sooner, and sent to the vendor for processing. These measurements will be used to document exposure rates within Area 1.

4.7 Borehole Sampling

The investigation activities will be conducted using sampling technology associated with the sonic drilling technique (ASTM D6914) or a conventional direct-push technology such as a Geoprobe®-type rig equipped with a 3" Geoprobe® Dual Tube sampling system with acetate liners (or equivalent). The Sonic drilling/Geoprobe® crew will proceed to each marked borehole location and continuous soil cores will be collected and logged.

At each boring location, soil cores will be advanced through any overburden and into the underlying landfill deposits, terminating in the underlying unconsolidated material. If refusal is met, the borehole location may be off-set at the discretion of the Project Manager. It is anticipated that the total depth of each borehole will be approximately 30 to 60 feet bgs but may extend as far as 80 feet bgs in places. Soil cores from these boreholes will be labeled with a unique sample identification number that will include a reference to the boring designation from the sampling map, the borehole number (if more than one borehole is taken at the same location), the core sequence number or depth interval, an arrow indicating the top of the soil core, and the date.

Soil cores obtained from each borehole will be examined by the project geologist/field engineer. At a minimum, the geologist/field engineer will identify the depths that soil transitions from one subsurface unit to the next and identify any stratum that may affect the installation or efficacy of the isolation/thermal barrier. The entire soil core from the borehole will be stored in sealed PVC pipes.

4.8 Subsurface Measurements

An integrated procedure using vertical scanning of the borehole (borehole gamma logging) and gamma scanning of the produced soil core will be used to identify subsurface gamma anomalies and match soil samples with those anomalies. Borehole logging will be used to assess whether measureable amounts of elevated subsurface gamma radiation exist in the borehole, and to determine the depth and thickness of any subsurface anomalies. Soil core gamma logging will be used to locate any soils in the sample tube that may produce elevated levels of gamma radiation. This integrated approach will allow samplers to identify the depth(s) of potentially impacted soils (indicated by the downhole gamma logs) even if the soil column in the sampling tube is displaced to a different depth in the tube during sampling.

4.8.1 Borehole Gamma Logging

Once the borehole has reached its total depth, a PVC sleeve will be inserted into the hole. A 1-inch NaI gamma probe with a long cable will be lowered into the sleeve and used to record one (1) minute radiation measurements at 6-inch intervals along the length of each borehole. These measurements will be recorded in counts per minute (cpm) and the depth of each measurement will be recorded as depth bgs in negative feet. For example, the depth of a gamma measurement taken at 3.5 feet bgs will be recorded as "-3.5 feet". This "gamma log" will be used to identify the depth bgs of any subsurface soil layers producing elevated radioactivity. A modified borehole logging procedure excerpted from the Auxier & Associates procedure manual is provided in **Appendix A**.

4.8.2 Soil Core Gamma Scanning

Concurrently with borehole gamma logging, any radioactivity associated with the soil core will be determined by taking 1-minute integrated gamma measurements at 1-foot intervals using a 3x3 inch NaI gamma detector along the length of the core(s) that contains the upper strata of fill and refuse material. After all measurements have been taken along the soil core tube, samples for laboratory analysis will be collected from those core intervals producing anomalous results. For the purpose of this work plan, anomalous areas are those intervals of soil producing a gamma response that is 30% greater than the median of all gamma responses observed for the same borehole. This 30% criterion, referred to as the Elevated Measurement Location (EML) criterion, is adapted from New Jersey's Field Sampling Procedure Manual dated 12.7.10. The procedure from this manual was selected because it provides a citable procedure developed by a reputable third party (New Jersey Department of Environmental Protection's Bureau of Radiation.)

4.8.3 Geological Examination of Soil Core

The project geologist/field engineer will review the core samples and log the boring based upon the cores and the corresponding depths. A geologic log for each boring will be developed.

4.9 SOIL SAMPLING

Soil samples will be collected based upon the results of the borehole gamma logging, soil core gamma scanning, and geological evaluation of the contents of the soil core. At a minimum, all anomalous intervals of the soil column identified in Section 4.8 will be sampled. Additional intervals of interest may be selected for discretionary sampling by the project geologist/engineer or RSO. At a minimum two (2) soil samples will be collected from each boring.

When sampling, the associated 1-foot interval of soil collected will be identified in the field notes for that tube and the sample associated with that interval will be sent for analysis at the analytical laboratory. The depth of the sample will be determined by measuring from the ground surface.

The volume of soil sample, type of sample container, and preservation requirements are provided on Table 1. Soil samples will be analyzed for isotopic Uranium, isotopic Thorium, and gamma spectroscopy at the Eberline Services Oak Ridge Laboratory located in Oak Ridge, TN using the methods listed in Table 1. Method Detection Activities (MDAs) for these methods are also indicated on Table 1.

Field duplicate samples will be collected at a frequency of one duplicate for every 10 investigative samples or one field duplicate sample per sampling event if less than 10 investigative samples are collected.

Table 1 - Analytical Methods and Sample Requirements

MATRIX	CONTAINER	PRESERVATIVE	ANALYTE	VOLUME OR MASS REQUIRED	METHOD REFERENCE	MDA [a]
Soil	0.5 liter large-mouth Nalgene jar or plastic ziplock bag	None	Isotopic Uranium	< 10 g	EML U-02 Modified	<1.0 pCi/g [b, c]
			Isotopic Thorium	< 10 g	EML Th-01 Modified	<1.0 pCi/g [c]
			Gamma emitters including: Bi-214 & Pb-214 (Ra-226) Ac-228 (Ra-228), and K-40	400-500 grams	LANL ER-130 Modified	<1.0 pCi/g [c]
Water	1 Gallon Cubitainer	pH <2.0 HNO_3	Gross Alpha & Beta	Two gallons in 1-Gal Cubitainers	EPA 900.0 Modified or EPA 900.1 Modified [d]	<5 pCi/L
			Isotopic Thorium		EML Th-01 Modified	<1.0 pCi/L
			Radium-226		EPA 903.0 Modified	<1.0 pCi/L
			Radium-228		EPA 904.0 Modified	<2.0 pCi/L
Air	47mm Filter	None	Gross Alpha & Beta	Air volume sampled $\geq 1 \times 10^8$ mL	EPA 900.0 Modified	$<5\times10^{-14}$ µCi/mL [e, f]
			Isotopic Thorium		EML Th-01 Modified	$<5\times10^{-14}$ µCi/mL [e, f]

[a] MDA = method detection activity

[b] pCi = picoCuries

[c] Standard MDA. Lower MDA's available.

[d] Dependent on dissolved solids content.

[e] uCi = microCuries

[f] Dependent on volume of air sampled.

4.10 Sample Handling and Shipping

Each sample will be placed in the sample container indicated on Table 1 and sealed. A sample label will be placed on the outside of the container. The sample label will include the unique sample identifier discussed below, client name, project location, analyses to be performed, any preservative included with the sample, the collection date and time, and the name of the person who collected the sample.

To be consistent with the system used in previous sampling campaigns, unique sample identifiers will consist of an alpha-numeric code including the area label, the borehole identifier, the sample type and matrix, followed by the sample depth. The numeric portion of the sample identifier describing the depth will be separated from the borehole information by a dash "-". The starting and ending depths will be separated by a dash. The identifiers expected for this sampling program are listed below:

- Area label: Area 1 (A1)
- Borehole ID: A four digit descriptor of the borehole location, such as 12-03 for the third borehole along corridor 12 or equivalent. Note the 2-digit number designating numerical order along the corridor (01, 02, … 10, etc.). This is desirable when sorting results for presentation.
- Sample Type and Matrix: IS (investigation soil)
- Sample Depth: This will consist of start and stop sample depths in feet with a dash between the two depths, such as 00.0-00.5 (0-6 inches). Note – grab samples of soil will have only one depth value associated with them (00.0-00.0).

For example, a soil sample collected in Area 1 (A1) along Path 4 (04) from the third borehole (03) for investigative purposes (IS) across a depth interval of 1 to 2 feet would be labeled:

A10403IS 01.0-02.0.

The sample containers will be stored in a secure location in a manner that maintains chain-of-custody requirements until such time as they are ready for shipment. If samples are selected for laboratory analysis, they will be logged on a chain-of-custody form and placed in a cooler.

A chain-of-custody form will accompany every shipment of samples to the analytical laboratory. The purpose of the chain-of-custody form is to establish the documentation necessary to trace possession from the time of collection to final disposal, and to identify the type of analysis requested. Any correction to the chain-of-custody record will be marked out with a single line, initialed and dated using black indelible ink by the person making the correction. Each chain-of-custody form will include signatures of the appropriate individuals indicated on the form. Shipping to the analytical laboratory will be via common courier directly to the laboratory.

The chain-of-custody form for that shipment will be placed in the cooler until the cooler is shipped. Prior to sealing the cooler, the cooler will be surveyed with a Ludlum Model 19 portable gamma radiation detector or equivalent and the maximum reading will be recorded on the chain-of-custody form. The original chain-of-custody form will be placed in the cooler and a copy retained at the Site. The cooler will be completely and securely sealed prior to shipment and a custody seal will be adhered on a side of the cooler from the lid to the body of the cooler. The seal will be signed and dated and clear packing tape placed over the seal. All samples will be packaged and shipped to the laboratory in accordance with USDOT regulations (see Auxier & Associates Procedure 3.8 "Sample Chain of Custody" in **Appendix A**).

4.11 SAMPLE PROCESSING AND ANALYSIS

Samples will be sent to Eberline Services Oak Ridge Laboratory for analysis. The samples will be received at the laboratory by the sample custodian. The custody-sealed coolers containing the samples will be opened and the contents inspected against the chain-of-custody form. Chain-of custody forms will be reviewed for completeness, and samples will be logged and assigned a unique laboratory sample number. Any discrepancies or abnormalities in samples will be noted by the laboratory and the Project Manager will be promptly notified.

All samples will be weighed prior to drying. After samples are dry, the samples will be reweighed and then ground to promote homogeneity. Results of the sample analyses are not expected to be received for four to six weeks from the time the samples are received by Eberline Services.

Investigative and field duplicate samples will be analyzed for the parameters using the methods listed on Table 1. Laboratory quality control (QC) samples will be prepared at the laboratory and analyzed along with the field samples to monitor the accuracy and precision of analysis. Quality Control and Quality Assurance internal to the Eberline Services Oak Ridge Laboratory; performance and system audits; control and maintenance of measurement and test equipment; data reduction, verification, reporting, and management; document control; and corrective action are included in the Oak Ridge Laboratory Quality Assurance Program Manual (Eberline, 2013), which is provided with this Work Plan as **Appendix B**. The Eberline Oak Ridge Laboratory successfully participates in annual Mixed Analyte Performance Evaluation Program (MAPEP) performance testing such as that conducted by the Department of Energy.

5 HEALTH AND SAFETY MONITORING

Procedures to support and monitor worker health and safety will be implemented in conjunction with any work performed at the Site. It is expected that the same procedures that were used during the Phase 1 GCPT investigation will also be used during Phases 1B, 1C and 2 work, with the exception that additional air monitoring activities will be conducted during the Phases 1B, 1C, and 2 programs. Additional details are contained in the HASP. A description of the particulate air monitoring activities is provided below.

In addition to the use of personal air monitoring pumps (see HASP), monitoring of possible radionuclide occurrences in airborne particulates will also be performed using fixed location air monitoring pumps and filters. Use of fixed location air monitoring pumps and filters allows for use of larger pumps which can sample a larger air volume than can be achieved using the more portable personal air monitoring pumps. This results in a larger particulate sample which generally produces a lower detection limit than the other methods used on this project.

Fixed location air monitoring will be performed using RADeCO H809-C air samplers (or equivalent) with 47 millimeter filters. These samplers include a two stage turbine blower capable of sampling at rates of 1 to 5 cubic feet per minute (30 to 140 liters per minute). The advantage of using these types of samplers is that they are light weight and can be operated using battery power and therefore can be easily located and re-located to meet the specific monitoring needs of the various investigative activities.

Fixed location air monitoring will be conducted at two locations during performance of the work including adjacent to the field trailer located along the south side of Area 1 and adjacent to the Bridgeton Landfill transfer station located to the west of Area 1. In addition, fixed location air monitoring will be performed at a third location along the downwind side of the boundary of the specific work area. The down-wind boundary placement will generally provide a worst-case indication of concentrations in air adjacent to the investigative activity being monitored. The location of this third monitoring station will vary depending on the specific investigative activities being conducted each day.

The primary purpose of the fixed location air monitors is to collect data to assess worker doses. They are therefore operated primarily during the investigative activities, anticipated to occur over a period of 60 to 80 hours per week. Filters will be collected weekly (or every other week if necessary to obtain sufficient sample volume to support low minimum detectable activity levels – see additional discussion below) and counted on-site using a Ludlum Model 2929 with a 43-10-1 alpha/beta detector for screening/operational monitoring purposes in accordance with the requirements set forth in the HASP.

Filters from the fixed location air monitoring stations will also be sent to the Eberline Services Oak Ridge, TN laboratory for analysis using low-background counters. The results will be used to report worker dosimetry for each phase of the investigation. Results will be compared to derived air concentrations of radionuclides for occupational exposure established by the Nuclear Regulatory Commission (NRC) [10 CFR Part 20, Appendix B, Table 1].

Pursuant to a request from EPA, the filters will also be analyzed for specific radioisotopes and the results will be compared to the effluent concentrations for air established by the NRC (10 CFR Part 20, Appendix B, Table 2) for assessment and control of dose to the public.

Using the mix of radionuclides published in the Baseline Risk Assessment (Auxier, 2000), 70% of the dose from any exposure to dust will be from particles containing the alpha emitter Thorium-230. The average annual release limit for Thorium-230 in effluent air is $3x10^{-14}$ microcuries per milliliter (µCi/ml) [NRC in 10 CFR 20, Appendix B, Table 2; Note: occupational standards are listed in Table 1 of this NRC Appendix B]. Assuming all of the alpha emissions are from Thorium-230, then the minimum detectable concentration (MDC) required to determine compliance with the Thorium-230 effluent limit will be less than $3x10^{-14}$ µCi/ml. The expected MDC for a one week sample will be on the order of 1 to $2x10^{-14}$ µC/ml for a 45 hour sample. Extending the sample duration to two weeks will reliably produce a minimum detectable concentration for gross alpha of $1x10^{-14}$ µCi/ml.

6 PROJECT TEAM

This Work Plan was prepared at the request of Bridgeton Landfill, LLC by Auxier & Associates, Inc. (A&A), a wholly owned subsidiary of USA Environment, LP, Feezor Engineering, Inc. (FEI), and Engineering Management Support, Inc. (EMSI). Roles and responsibilities of these project team members as well as subcontractors are as follows.

6.1 BRIDGETON LANDFILL, LLC

Bridgeton Landfill, LLC will retain overall management for the project and will retain Feezor Engineering, Inc,. Auxier & Associates, Engineering Management Support, Inc. and other necessary subcontractors to provide services necessary to identify a proposed alignment and develop design information for an isolation/thermal barrier.

6.2 FEEZOR ENGINEERING, INC.

Feezor Engineering, Inc. (FEI) is the Project Manager selected to manage the investigation and coordinate required operations on and off the site. FEI will supply GPS coordinates for the selected sampling locations. FEI will verify that all geospatial data are correct and fully documented. FEI will determine that:

- Actual sample locations correspond to specified coordinates;
- Elevation and depth bgs data are available for all actual sample locations, and
- Coordinates, elevations and depths of any relocated sample locations are captured and documented.

FEI will supply a geologist/field engineer to accompany the field team and examine the soil cores. The geologist/field engineer will receive the cores from the driller, label them, and prepare geologic/engineering descriptions of the soil cores as they are produced by the drillers. FEI will provide maps and drawings using data collected. FEI will also develop the final report summarizing the findings of the Phase 1B, 1C, and 2 investigations.

6.3 AUXIER & ASSOCIATES, INC.

A&A personnel have responsibility for all radiological measurements described in this plan and collecting, packaging, and shipping samples to the analytical laboratory. A&A will collate, validate, manage, and analyze the radiological data produced by this sampling program and prepare and submit a report summarizing the results.

A&A will supply the RSO and Radiation Control Technician (RCT) [see RCT roles and responsibilities in Section 7], to be determined, who will manage and perform the radiological measurements and sampling described in this work plan and the HASP. Mr. Mike Bollenbacher, CHP of A&A will provide technical oversight on the radiological aspects of the field sampling and analytical activities.

6.4 Engineering Management Support, Inc.

Engineering Management Support, Inc. (EMSI) is responsible for investigation and evaluation of potential remedial alternatives for Operable Unit 1. EMSI will provide oversight of the isolation/thermal barrier investigation and technical consultation relative to occurrences of RIM in Area 1, the proposed investigative and health and safety monitoring activities, and evaluation of the results of the field and laboratory investigations. Because EMSI is responsible for OU-1 work, and the isolation/thermal barrier investigation is being performed under the Administrative Order on Consent (AOC) for OU-1, EMSI will also provide coordination between the investigative team and EPA and perform reporting required under the AOC.

6.5 Drilling Subcontractor

Frontz Drilling will be the drilling subcontractor for the sonic drilling activities. The drilling subcontractor will provide for soil sampling by installing minimum 2.5 inch diameter boreholes at surveyed and marked locations. The drilling subcontractor will insert plastic sleeves in the borehole after cores have been extracted to allow for downhole gamma logging of the boreholes. Frontz Drilling will supply all materials necessary to collect soil cores from those boreholes including direct push equipment capable of advancing boreholes to depths of up to 100 feet, flexible or rigid liners and end caps, borehole inserts, and any necessary support vehicles and portable work tables.

Any additional GCPT drilling that may be conducted in conjunction with Phase 1C will be performed by ConeTec, the drilling subcontractor that performed the Phase 1 GCPT work.

6.6 Surveying Contractor

Weaver Boos will provide land surveying as necessary to support task completion. Specifically, the proposed and actual locations of the borings will, to the extent that they do not coincide with previously surveyed drilling locations, be surveyed prior to and/or upon completion of borehole drilling activities.

6.7 Analytical Laboratory

Eberline Services Oak Ridge Laboratory located in Oak Ridge, Tennessee (Eberline) will perform laboratory analyses of the soil/waste samples collected from the boreholes. Eberline will also analyze particulate samples obtained in conjunction with the air monitoring activities. Eberline is one of the nation’s largest radiochemistry laboratory networks and offers comprehensive radiochemical analyses including environmental radiochemistry. Eberline holds numerous laboratory certifications, accreditations, and approvals; including National Environmental

Laboratory Accreditation Program (NELAP) and Department of Energy Consolidated Accreditation Program (DOECAP). Eberline has previously and continues to provide radiochemistry analytical services in support of OU-1 monitoring activities at the Site.

7 CONTAMINATION SURVEYS AND DECONTAMINATION PROCEDURES

The potential to spread contamination will be mitigated by establishing readily identifiable areas around activities having the potential to encounter radiological materials. Access to these areas, called ”Permitted Areas” in this work plan, will be controlled and limited to properly trained individuals who have read, understood, and signed the daily Radiation Work Permit governing activities in an area or areas. Equipment and personnel leaving these Permitted Areas will be surveyed as described below. If contamination is identified, the contamination will be removed and the equipment rechecked. This is an iterative process that will continue until equipment and personnel meet exit criteria.

7.1.1 Radiological Surveys

Surveys will be used to monitor and control exposures and the potential spread of contamination. The following subsections describe the surveys to be used and their requirements.

7.1.1.1 Baseline Entry Survey – Equipment

All vehicles and large equipment entering Area 1 will be surveyed by the Radiation Control Technician (RCT) for fixed alpha and beta contamination before their initial entrance into Area 1. The survey will be conducted using a Ludlum Model 2360 scaler/ratemeter with a Model 43-93 alpha/beta detector probe (or equivalent), as described in A&A Procedure 2.7 (**Appendix A**).

7.1.1.2 Permitted Area Exit Survey - Personnel

Personnel exiting a Permitted Area will have their shoes and clothing scanned upon leaving the area, as described in A&A Procedure 2.7. The name of the individual, the results of the exit survey, the location, and the times they entered and left the area will be recorded on a standard form such as A&A Form 11 (Personnel Monitoring Form) or a log sheet attached to a copy of the Radiation Work Permit. A reading of two (2) times the ambient background level will require decontamination before leaving the area.

7.1.1.3 Permitted Area Exit Survey - Equipment

Heavy equipment working inside a Permitted Area will be surveyed by the RCT before leaving the area. All surfaces in contact with soil will be scanned for alpha, beta and gamma surface activity with a Ludlum Model 12 survey meter coupled to a Model 44-9 alpha/beta/gamma pancake detector (or equivalent) as described in A&A Procedure 2.7. A reading of two (2) times the ambient background level will require the equipment to be decontaminated and resurveyed before it leaves the Permitted Area.

Sections of the downhole drilling equipment will be sampled with a swipe between sampling locations to detect any removable activity on the surface of the tool string. The swipe samples will be screened in the field with a Ludlum Model 12 survey meter coupled to a Model 43-5 alpha detector, or equivalent. A final measurement of alpha and beta activity on the smear will be performed using a Ludlum Model 2929 scaler coupled to a Ludlum Model 43-10-1 alpha/beta counter or a low-background alpha/beta counter such as an XLB-5.

7.1.1.4 Final Release Survey - Equipment

Equipment working inside a Permitted Area and equipment that might inadvertently contact contaminated soil outside a cleared easement will be surveyed by the RCT before leaving Area 1. All surfaces in contact with soil will be scanned for alpha and beta contamination with a Ludlum Model 2360 scaler/ratemeter coupled with a Model 43-93 probe (or equivalent) as described in A&A Procedure 2.7.

Removable contamination will be sampled by swiping 100 cm^2 areas on parts of the equipment that were in contact with soil surfaces as described in A&A Procedure 3.6. These smear samples will be counted with a Ludlum Model 2929 scaler coupled to a Ludlum 43-10-1 detector.

If contamination is found, the vehicle will be decontaminated until it meets final release standards listed in Table 2. The equipment identification and the final results will be recorded on the appropriate equipment release form from the A&A Procedures Manual and the equipment will be unconditionally released from Area 1.

Table 2 - Final Release Survey Limits for Equipment

Parameter	Acceptable Surface Contamination Levels [a]	Equivalent Meter Response in the Field [b]
Fixed Alpha (Ra-226 & Th-230)	100 dpm/100cm^2, average 300 dpm/100cm^2, maximum	20 cpm Mo 2360/Mo 43-93 60 cpm Mo 2360/Mo 43-93
Fixed Beta (U_{nat} & assoc. decay products)	5,000 dpm/100cm^2, average 15,000 dpm/100cm^2, maximum	750 cpm Mo 2360/Mo 43-93 2250 cpm Mo 2360/Mo 43-93
Removable Alpha	20 dpm/100cm^2, average	Na
Removable Beta	1,000 dpm/100cm^2, average	Na

[a] From U.S. Atomic Energy Commission's RegGuide 1.86 "*Termination of Operating Licenses for Nuclear Reactors*," Table 1 Acceptable Surface Contamination Levels.

[b] Nominal values based on default efficiencies published by Ludlum Instruments on their web site (20% α, 15% β). Meter efficiencies may be reevaluated at the site.

7.1.2 Equipment Decontamination

All equipment (including but not limited to the drill rig) will be surveyed. If radioactive contamination is detected, the equipment will be decontaminated. A phased approach to decontamination will be employed to minimize the generation of solid waste and waste water.

7.1.2.1 Dry Decontamination

It is expected that any contamination will be associated with loose, removable dirt and mud that may attach to equipment surfaces during operations. If contamination is detected on equipment after operations are completed in a boring location, the equipment will be decontaminated before moving to the next boring location. Visual patches of dirt and mud will be removed from the contaminated surfaces of the equipment using damp wipes, brushes, and scrapers. Used decontamination supplies will be placed in marked containers or bags. The remainder of material removed during dry decontamination will be placed in a separate container with hard plastic or metal sides and staged for retrieval and sampling. Any solid radioactive waste generated will be packaged and characterized for handling as discussed in Section 7.1.2.3 .

7.1.2.2 Wet Decontamination of Equipment

If dry decontamination is not sufficient to meet release levels, the equipment will be moved to the radiological decontamination pad. Contaminated surfaces will be scrubbed with brushes and soapy water until they are visually clean. The equipment will be surveyed again for both alpha and beta surface activity. If fixed or removable activity exceeding the release limits is found, the contaminated surface will be decontaminated using more aggressive methods such as pressure washing or abrasive blasting until the release criteria are met.

7.1.2.3 Waste/Water Management

Water used to decontaminate equipment will be placed in marked holding tanks and/or drums, sampled, and packaged and shipped to a licensed, managed disposal site. The volume of sample required, sample container type, and preservative requirements for any water sample(s) are provided on Table 1. Decontamination water samples will be analyzed for gross alpha and beta and isotopic Uranium. If the gross alpha results are greater than 15 pCi/L, then the sample(s) will be analyzed further for Radium-226 and isotopic Thorium. Analytical methods and MDAs are included on Table 1.

Any solid radioactive waste generated will be packaged and characterized for shipping. This material will be shipped to a managed disposal/treatment facility that is permitted to receive the waste.

7.1.2.4 Final Housekeeping Wash-down

Any equipment released from Area 1 will be washed with water to remove visible dirt from its surfaces prior to its removal from the project. This final housekeeping can be performed in an uncontrolled area and any water generated from this final cleaning of previously released equipment will be considered unimpacted.

7.1.3 Decontamination Pads

Two separate decontamination pads were constructed during the Phase 1 GCPT investigation. A radiological decontamination pad was constructed near PVC-38. This pad will be used to decontaminate equipment failing the free-release radiological requirements and was constructed to contain solid waste and decontamination water.

A second pad was also constructed for general cleaning of equipment that has not been exposed to RIM materials. This gravel surface pad is located adjacent to the fence near the entrance road to Area 1.

8 QUALITY ASSURANCE

The various activities and requirements to be implemented to support collection of data of the quality necessary to support decision making for the isolation/thermal barrier investigation and design are presented in this work plan. This section provides an overview of the specific data quality objectives for the analytical laboratory data. A listing of where the various requirements of a quality assurance project plan (QAPP) are located in this work plan is also included. In addition, the specific data validation procedures to be employed to assess the quality of the data provided by the analytical laboratory are presented in this section.

8.1 ANALYTICAL DATA QUALITY OBJECTIVES

Samples of waste/soil material will be obtained and submitted to Eberline for determination of radionuclide activity levels. As discussed in Section 1.1.1 of this work plan, RIM is defined as materials that contain any of the following:

- Combined radium-226 and radium-228 at levels greater than 5 pCi/g above background (e.g., 7.9 pCi/g);
- Combined thorium-230 and thorium-232 at levels greater than 5 pCi/g above background (e.g., 7.9 pCi/g); and
- Total uranium greater than 50 pCi/g plus background (e.g. 54.5 pCi/g) [EMSI, 2011].

The MDA levels for analytical methods listed on Table 1 should provide data of sufficient quality to allow for characterization of the waste/soil samples necessary to identify any occurrences of RIM in the areas being considered for construction of an isolation/thermal barrier.

Analytical data will also be developed to assess worker doses and verify that particulate concentrations of radionuclides in air do not pose a risk to the general public. Specifically, the particulate filter samples will be submitted to Eberline for analysis of thorium-230. As discussed in Section 6 of this work plan, the effluent limit for airborne thorium-230 established by the NRC (10 CFR Part 20 Appendix B, Table 2) is 3×10^{-14} µCi/ml. Therefore, the minimum detectable concentration (MDC) required from the analytical laboratory to determine compliance with the thorium-230 effluent limit will be less than 3×10^{-14} µCi/ml. Assuming that all of the alpha emissions result from decay of thorium-230, the MDC for gross alpha in a sample containing 1.8 x 108 mL (60 liters per minute for 50 hours) will be 2.8×10^{-14} µCi/ml. Extending the sample duration to two full weeks (100 to 120 hours) will produce a sample volume of approximately 3.6×10^{8} or more, and result in minimum detectable concentrations for gross alpha and thorium-230 of 1 to 2×10^{-14} µCi/ml. Therefore, the proposed sampling and analyses should provide data of sufficient quality to evaluate potential particulate occurrences of radionuclides in air.

8.2 QUALITY ASSURANCE PROJECT PLAN REQUIREMENTS

EPA has established guidance relative to the requirements for Quality Assurance Project Plans (EPA, 2002). A listing of the QAPP requirements and the location in this work plan where these requirements are addressed (if and as appropriate for the scope of the investigations) are presented on Table 3.

8.3 DATA VALIDATION

The data validation process will consist of evaluation of the results of individual samples collected and analyzed to determine if results are within acceptable limits. These quantitative or qualitative limits of acceptability are defined for Precision, Accuracy, Representativeness, Comparability, and Completeness (PARCC), as discussed below.

Precision: Precision is defined as the agreement between a set of replicate measurements without assumption or knowledge of the true value. Agreement is expressed as either the Relative Percent Difference (RPD) for duplicate measurements, or the range and standard deviation for larger numbers of replicates. Data regarding precision are obtained by analyzing duplicate or replicate samples.

Accuracy: Accuracy is a measure of the closeness of a sample analysis result to the "true" value. Accuracy of sample analyses is evaluated using laboratory control samples that are prepared and analyzed by the analytical laboratory as part of the analyses of the various batches (lots) of samples.

Representativeness: Representativeness is the degree to which data accurately and precisely represent characteristics of a population, parameter variations at a sampling point, or an environmental condition. For this investigation, representativeness will be ensured by the selection of sampling locations in accordance with the goals of the sampling design requirements presented in Section 1.2.

Comparability: Data are comparable if collection techniques, measurement procedures, methods, and reporting units are equivalent for the samples within a sample set. These criteria allow comparison of data from different sources. Comparable data will be obtained by specifying standard units for physical measurements and standard procedures for sample collection, processing, and analysis.

Completeness: Data are considered complete when a prescribed percentage of the total intended measurements and samples are obtained. Analytical completeness is defined as the percentage of valid analytical results requested. For this investigation, collection of samples at a minimum of 80% percent of the planned sampling locations must be obtained to achieve a satisfactory level of data completeness.

Level III data validation will be performed consisting of manually examining data deliverables to determine data quality for the analytical results for field investigative and duplicate samples. Radionuclide data will be validated in general accordance with the guidelines and criteria specified in the MARLAP Manual (EPA, 2004). Data validation will include application of appropriate data qualifiers to the analytical results based on adherence to method protocols and project-specific QA/QC limits.

The following elements will be reviewed for compliance as part of the data validation:

- Methodology;
- Holding Times;
- Calibration;
- Blanks;
- Spikes;
- Duplicates;
- LCSs;
- Practical Quantitation Limits;
- Analyte Identification; and
- Analyte Quantification.

During the subsequent data evaluation process, the sampling, analysis, and data collection documentation will also be reviewed for completeness and consistency with data quality objectives. Data validation reports will be reviewed to identify any limitations associated with the analytical data.

Table 3 – Crosswalk Between Quality Assurance Project Plan Requirements & Workplan Sections

Element No.	Element Description	Work Plan Page/Section	Comments
A1	Title and Approval Sheet	Page i	Note approval of the work plan will be separately provided by letter or e-mail from EPA
A2	Table of Contents	Page ii	
A3	Distribution List	Transmittal letter	
A4	Project/Task Organization	Sections 1.2 and 10	
A5	Problem Definition and Background	Section 1.1	
A6	Project/Task Description	Section 1.2	
A7	Quality Objectives and Criteria	Section 8.1	
A8	Special Training/Certifications	Not applicable	
A9	Documentation and Records	Section 9	
B1	Sampling Process Design	Section 4	
B2	Sampling Methods	Section 4	
B3	Sample Handling and Custody	Section 4.10	
B4	Analytical Methods	Table 1	
B5	Quality Control		
B6	Instrumentation/Equipment Testing, Inspection, and Maintenance	Health and Safety Plan	
B7	Instrument/Equipment Calibration and Frequency	Health and Safety Plan	
B8	Inspection/Acceptance of Supplies and Consumables	Not applicable	
B9	Non-direct Measurements	Section 4.8	
B10	Data Management	Section 9	
C1	Assessments and Response Actions	Not applicable	Work will be completed prior to receipt of analytical results. Any data quality issues identified during data validation will be addressed directly with the laboratory. Sample holding times are sufficiently long to all for re-analysis/additional analyses will be performed to meet project objectives if necessary.
C2	Reports to Management	Section 9	
D1	Data Review, Verification and Validation	Section 8.3	
D2	Verification and Validation Methods	Section 8.3	
D3	Reconciliation with User Requirements	Section 8.3	

9 REPORTING

Field investigation activities and the findings from these efforts will be summarized in a stand-alone Subsurface Investigation Summary Report.

The field data (boring logs, soil screening data, survey data, etc.) will be recorded daily on paper forms and log books. These paper records will be maintained in a managed repository such as an office or a climate controlled storage facility for future reference.

Analytical results will be sent in electronic format from the laboratory to Auxier & Associates. Laboratory analytical data will be recorded digitally and maintained in a relational database. Full Level III laboratory reports containing documentation of the analytical process, QA/QC data and analytical instrument performance will be sent in electronic or paper format from the laboratories to Auxier & Associates and EMSI. These analytical reports will include:

- Copies of completed chain of custody forms,
- Instrument calibration and/or instrument quality control records,
- Results for blanks and spikes associated with the reported results,
- Results for duplicates,
- Sufficient documentation to reproduce calculated results from instrument responses, and
- A case narrative describing the analytical process used to produce the published results.

All of the laboratory data will be validated by examining the test results. The laboratory reports and validation packets will be maintained at Auxier & Associates.

Information regarding the progress of the field work and sampling activities will be provided in the monthly progress reports for West lake Landfill Operable Unit 1 (OU-1) prepared by EMSI. Analytical reports will also be provided by EMSI as they are received in conjunction with submittal of the monthly progress reports for OU-1.

FEI will author a final report summarizing:

- Field preparations;
- Boring locations and sample locations;
- Lithology logs;
- Analytical testing and validation results; and
- A discussion on the feasibility of the isolation/thermal barrier alignment.

10 Anticipated Project Schedule

An anticipated project schedule is provided on Figure 4. Significant factors affecting the overall project schedule including drill rig availability, weather conditions, time required to perform laboratory analyses to achieve the minimum detectable activity levels required to meet the project data quality objectives, time required to validate the laboratory analytical data, time required to review the results of the field and laboratory data and finalize the scope of work and specific sampling requirements for the subsequent phase of work. Laboratory reports are expected to be received four to six weeks after submission of samples. Data validation is anticipated to require two to four weeks and is dependent upon the validator's schedule at the time the analytical reports are made available. The investigation summary report is anticipated to be complete and ready for submittal to the EPA one month after the analytical results are received and validated.

As discussed with EPA and elsewhere in this report, it is the intent of Bridgeton Landfill to work cooperatively with EPA to maximize efficiencies and minimize downtime between investigative steps. To this goal, this work plan will be updated through addenda addressing the next investigational steps and the parties will work cooperatively to streamline comments and revisions to ensure that work can proceed efficiently to completion.

11 REFERENCES

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EPA, 2002, Guidance for Quality Assurance Project Plans (QA/G-5), Final, U.S. Environmental Protection Agency, Quality Assurance Management Staff, EPA/600/R-00/007.

EPA, 1998, Memorandum: Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites, OSWER Directive no. 9200.4-25, February 12.

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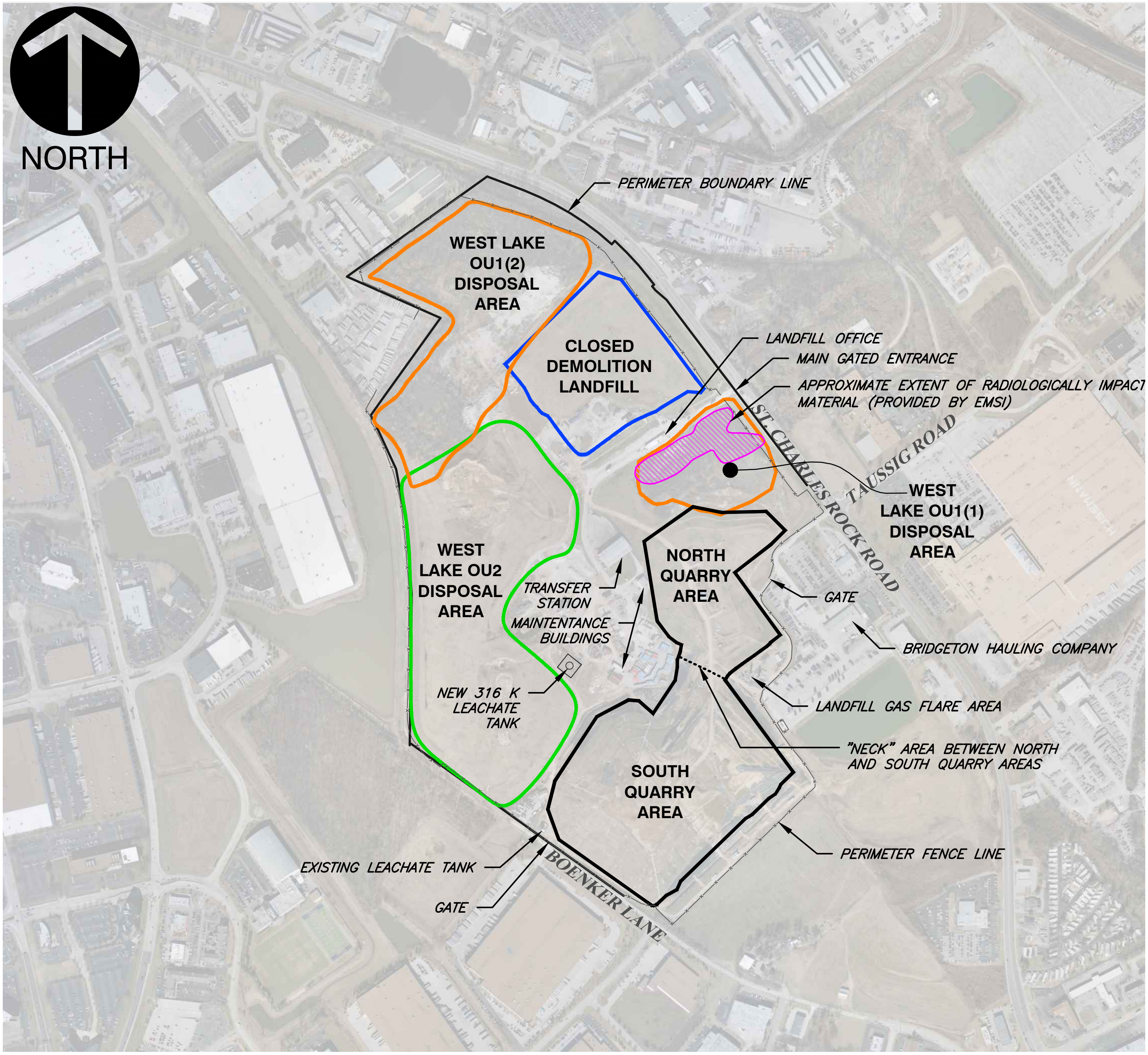
FIGURES



REFERENCE

1. AERIAL IMAGERY PROVIDED BY EAST WEST GATEWAY COORDINATING COUNCIL OF MISSOURI AND ILLINOIS, COLLECTED IN LATE FEBRUARY AND EARLY MARCH OF 2012.

2. BOUNDARY INFORMATION PROVIDED BY SHERBUT–CARSON & ASSOCIATES, P.C. DRAWING NAME–1111 LEASE EXHIBIT.DWG RECEIVED ON 03/04/2013

SCALE IN FEET

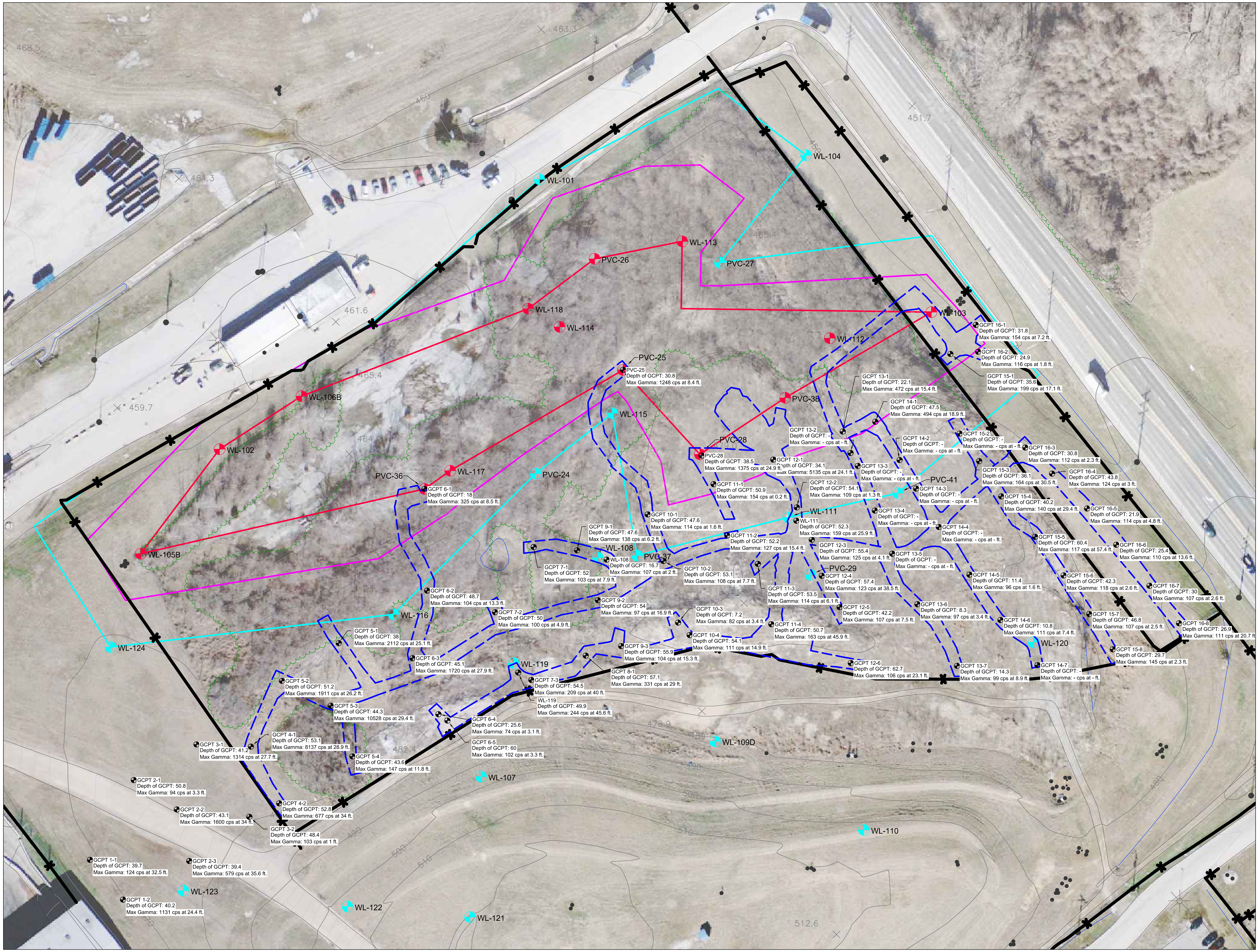
0 1000 2000

BRIDGETON LANDFILL, LLC
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI

FACILITY MAP

DRAWN BY: MSP	CHECKED BY: MRB	APPROVED BY: DRAFT	FIGURE NO.: 1
DATE: JUN. 2013	DWG SCALE: 1"=1000'	PROJECT NO: 131-178.0001	

P:\2013\130-484\-CADD\Dwg\SolidWaste\131178-Figure_1.dwg{FACILITY MAP} LS:(6/27/2013 – ccolthorp) – LP: 6/27/2013 11:02 AM



GCPT Boring	Date Completed	Maximum Depth	Maximum Gamma Count	Depth of Maximum Gamma Count
		(feet)	(Counts per Second)	(feet)
GCPT - 1.1	11/25/2013	39.7	124.0	32.5
GCPT - 1.2	11/25/2013	40.2	1,131.3	24.4
GCPT - 2.1	11/24/2013	50.8	93.5	3.3
GCPT - 2.2	11/24/2013	43.1	1,600.0	34.0
GCPT - 2.3	11/24/2013	39.4	578.7	35.6
GCPT - 3.1	11/24/2013	41.2	1,313.5	27.7
GCPT - 3.2	11/24/2013	48.4	103.1	1.0
GCPT - 4.1	11/14/2013	53.1	8,136.6	28.9
GCPT - 4.2	11/14/2013	52.8	677.4	34.0
GCPT - 5.1	11/19/2013	38.0	2,112.3	25.1
GCPT - 5.2	11/18/2013	51.2	1,911.4	26.2
GCPT - 5.3	11/19/2013	44.3	10,527.7	29.4
GCPT - 5.4	11/19/2013	43.6	147.0	11.8
GCPT - 6.2	11/19/2013	48.7	104.3	13.3
GCPT - 6.3	11/19/2013	45.1	1,720.3	27.9
GCPT - 6.4	11/16/2013	25.6	73.9	3.1
GCPT - 6.5	11/16/2013	60.0	101.8	3.3
GCPT - 7.1	11/15/2013	52.0	103.4	7.9
GCPT - 7.2	11/19/2013	50.0	100.2	4.9
GCPT - 7.3	11/16/2013	54.5	209.3	40.0
GCPT - 8.1	11/15/2013	57.1	330.9	29.0
GCPT - 9.1	11/15/2013	47.6	138.0	6.2
GCPT - 9.2	11/19/2013	54.0	97.1	16.9
GCPT - 9.3	11/15/2013	55.9	103.8	15.3
GCPT - 10.1	11/19/2013	47.6	113.8	1.6
GCPT - 10.2	11/20/2013	53.1	108.1	7.7
GCPT - 10.3	11/18/2013	7.2	81.5	3.4
GCPT - 10.4	11/18/2013	54.1	110.7	14.9
GCPT - 11.1	11/21/2013	50.9	153.5	0.2
GCPT - 11.2	11/20/2013	52.2	126.9	15.4
GCPT - 11.3	11/20/2013	53.5	114.3	6.1
GCPT - 11.4	11/18/2013	50.7	163.2	45.9
GCPT - 12.1	11/20/2013	34.1	5,135.0	24.1
GCPT - 12.2	11/20/2013	54.1	109.1	1.3
GCPT - 12.3	11/21/2013	55.4	124.6	4.1
GCPT - 12.4	11/21/2013	57.4	122.9	38.5
GCPT - 12.5	11/21/2013	42.2	107.2	7.5
GCPT - 12.6	11/18/2013	62.7	106.3	23.1
GCPT - 13.1	11/21/2013	22.1	471.7	15.4
GCPT - 13.2	11/21/2013	No boring refusal less than 5 '		
GCPT - 13.3	11/21/2013	No boring refusal less than 5 '		
GCPT - 13.4	11/21/2013	No boring refusal less than 5 '		0.0
GCPT - 13.5	11/22/2013	No boring refusal less than 5 '		0.0
GCPT - 13.6	11/22/2013	8.3	96.7	3.4
GCPT - 13.7	11/22/2013	14.3	98.8	8.9
GCPT - 14.1	11/22/2013	47.5	494.0	18.9
GCPT - 14.2	11/22/2013	No boring refusal less than 5 '		
GCPT - 14.3	11/22/2013	No boring refusal less than 5 '		
GCPT - 14.4	11/22/2013	No boring refusal less than 5 '		
GCPT - 14.5	11/22/2013	11.4	96.2	1.6
GCPT - 14.6	11/22/2013	10.8	110.9	7.4
GCPT - 14.7	11/22/2013	No boring refusal less than 5 '		
GCPT - 15.1	11/23/2013	35.6	199.0	20.3
GCPT - 15.2	11/23/2013	No boring refusal less than 5 '		
GCPT - 15.3	11/23/2013	36.1	163.8	30.5
GCPT - 15.4	11/22/2013	40.2	140.0	29.4
GCPT - 15.5	11/22/2013	60.4	117.4	57.4
GCPT - 15.6	11/22/2013	42.3	118.3	2.6
GCPT - 15.7	11/22/2013	46.8	107.4	2.5
GCPT - 15.8	11/22/2013	29.7	145.4	2.3
GCPT - 16.1	11/23/2013	31.8	153.8	7.2
GCPT - 16.2	11/23/2013	24.9	115.8	1.8
GCPT - 16.3	11/23/2013	30.8	112.4	2.3
GCPT - 16.4	11/23/2013	43.8	124.1	3.0
GCPT - 16.5	11/23/2013	21.9	114.4	4.8
GCPT - 16.6	11/23/2013	25.4	110.0	13.6
GCPT - 16.7	11/23/2013	30.0	106.9	2.6
GCPT - 16.8	11/23/2013	26.9	110.8	20.7
PVC-25	11/14/2013	30.8	1,248.0	8.4
PVC-28	11/14/2013	38.5	1,375.2	24.9
PVC-36 (GCPT - 6.1)	11/14/2013	18.0	324.5	8.5
WL-108	11/15/2013	16.7	106.8	2.0
WL-111	11/13/2013	52.3	159.0	25.9
WL-119	11/15/2013	49.9	243.6	45.6

0 40 80 Feet

LEGEND

- GCPT LOCATION
- ELEVATED DOWNHOLE GAMMA READING
- BOUNDARY OF ELEVATED DOWNHOLE READINGS
- NON-ELEVATED DOWNHOLE GAMMA READING
- BOUNDARY OF NON-ELEVATED DOWNHOLE READINGS
- INTERPOLATED RIM LIMITS
- FENCE
- ROCK

WEST LAKE LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044

WEST LAKE LANDFILL OU-1
AREA 1 RIM INVESTIGATION

GCPT STATUS through 11-29-13

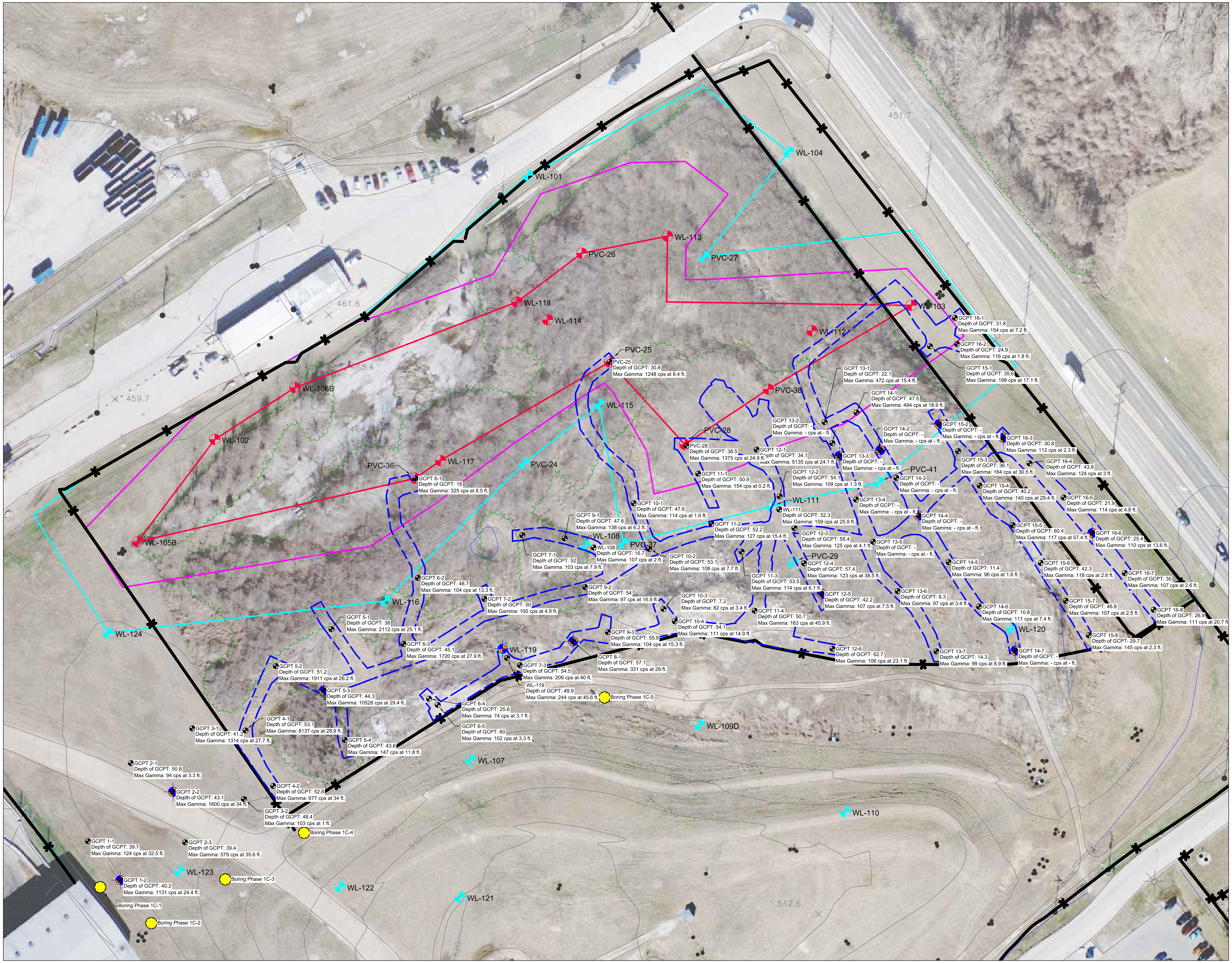
FEEZOR ENGINEERING, INC.
Engineering for a Better World

DECEMBER 2013
DESIGNED BY: PML
APPROVED BY: DRF

REVISION	DATE

DRAWING NO.: 2

PROJECT NUMBER: BT-012 | FILE PATH:



LEGEND

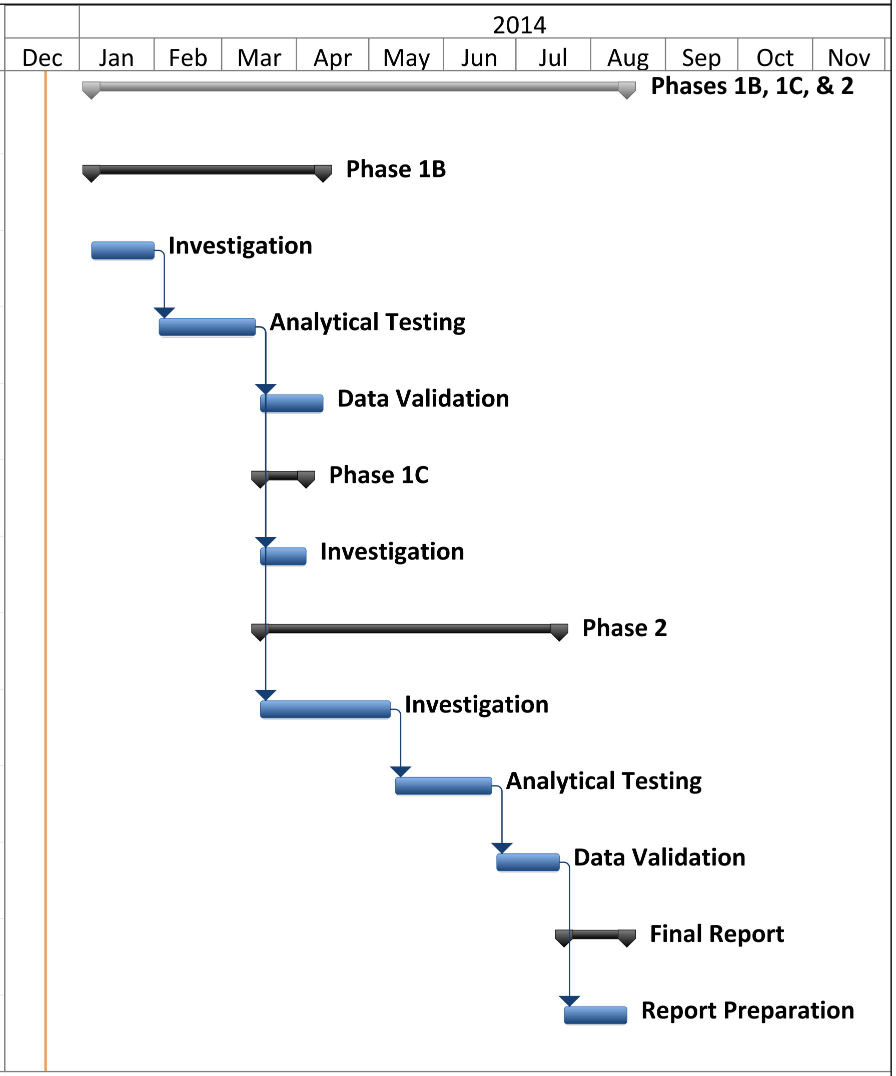
- GCPT LOCATION
- ELEVATED DOWNHOLE GAMMA READING
- BOUNDARY OF ELEVATED DOWNHOLE READINGS
- NON-ELEVATED DOWNHOLE GAMMA READING
- BOUNDARY OF NON-ELEVATED DOWNHOLE READINGS
- INTERPOLATED RIM LIMITS
- FENCE
- ROCK
- PROPOSED PHASE 1B SONIC BORING LOCATION
- PROPOSED PHASE 1C BORING LOCATION (EITHER SONIC DRILLED OR GCPT)

0 40 80 Feet

WEST LAKE LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	WEST LAKE LANDFILL OU-1 AREA 1 RIM INVESTIGATION	FEEZOR ENGINEERING, INC. Engineering for a Better World	DECEMBER 2013 DESIGNED BY: PML APPROVED BY: DRF
PROPOSED PHASE 1B AND 1C BORING LOCATIONS			DRAWING NO.: **3**
PROJECT NUMBER: BT-012	FILE PATH:		REVISION / DATE

Figure 4 - Proposed Schedule

ID	Task Name	Duration	Start	Finish
0	**Phases 1B, 1C, & 2**	**160 days**	**Mon 1/6/14**	**Fri 8/15/14**
1	**Phase 1B**	**70 days**	**Mon 1/6/14**	**Fri 4/11/14**
2	Investigation	20 days	Mon 1/6/14	Fri 1/31/14
3	Analytical Testing	30 days	Mon 2/3/14	Fri 3/14/14
4	Data Validation	20 days	Mon 3/17/14	Fri 4/11/14
5	**Phase 1C**	**15 days**	**Mon 3/17/14**	**Fri 4/4/14**
6	Investigation	15 days	Mon 3/17/14	Fri 4/4/14
7	**Phase 2**	**90 days**	**Mon 3/17/14**	**Fri 7/18/14**
8	Investigation	40 days	Mon 3/17/14	Fri 5/9/14
9	Analytical Testing	30 days	Mon 5/12/14	Fri 6/20/14
10	Data Validation	20 days	Mon 6/23/14	Fri 7/18/14
11	**Final Report**	**20 days**	**Mon 7/21/14**	**Fri 8/15/14**
12	Report Preparation	20 days	Mon 7/21/14	Fri 8/15/14



Appendix A

Auxier & Associates Radiological Surveying and Sampling Procedures

PROCEDURE 2.1
INSTRUMENTATION: CALIBRATION & QUALITY CONTROL

1.0 PURPOSE

1.1 To describe the general approach to calibration and quality control checks of survey instruments.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Calibration

3.1.1 Instruments to be used for quantitative measurements are source calibrated a minimum of every twelve months; more frequent calibration may be necessary for some projects or applications to satisfy requirements of the responsible regulatory agency or following repair of the instrument. Exception: A properly calibrated Pressurized Ionization Chamber may be used as a secondary standard to calibrate response of a gamma detector, relative to true exposure rate (refer to Procedure 2.5).

3.1.2 Calibration is to be performed with standards traceable to the National Institute of Standards and Technology (NIST) or other industry recognized standards organizations.

3.1.3 Records will be maintained for each detector and readout instrument, detailing the calibration and maintenance history. Originals of calibration records are to be maintained at the Knoxville, Tennessee facility; however, copies should accompany instruments to the field measurement location.

3.1.4 Calibration will be performed by the instrument manufacturer or other outside organization. A&A will provide directions/specifications for calibration by outside agencies. An exception to manufacturer calibration is calibration of gamma detectors, using a pressurized ionization chamber (see Procedure 2.5). Calibration for response of surface contamination monitors to radionuclides or radionuclide mixtures for which commercial calibration services are not available or practical may necessitate in-house determination of source response or theoretical calculation of response, based on estimated parameters, e.g., from draft NUREG-1507. If in-house calibration is performed, detailed procedures will be developed, approved by the Field Survey Resources Committee, and placed in the appropriate project file.

3.1.5 Instruments, such as a pressurized ionization chamber, may be calibrated as a detector/readout combination; if calibrated in this manner, quantitative measurements are made only with the components and parameters for which the combination was calibrated.

3.1.6 Detectors and readouts, which are individual pieces of equipment, are usually calibrated separately; however, a calibrated detector may be used with various calibrated readout instruments, even if a specific source calibration of the combination has not been performed. To enable such use, the baseline response of the calibrated detector to a designated check source is determined immediately after return of the detector from calibration, using a readout instrument (for which the calibration is also current) with the operating parameters, e.g., high voltage and threshold (input discriminator), set according to those parameters at which the detector was calibrated.

Where possible, for an analog readout instrument, select a scale on which the source will provide a reading of between half- and full-scale; for an integrating digital readout instrument select a count time which will result in accumulation of at least 10,000 counts. Determine and record on the appropriate form, the gross and net instrument response on the Baseline Response record form. For instruments that will be operated in the scaler mode, repeat the determination ten times and calculate the average; one reading is recorded for instruments to be operated in the ratemeter mode. A range of $\pm$ 20 % of that response to the designated source is established as the criterion for evaluating acceptance of other readouts (with properly set operating parameters) with that detector. Each detector/readout combination, which satisfies the acceptance criterion for the designated baseline check source may be assumed to be responding with the efficiency established for the detector. This record is filed with other detector response, calibration, and maintenance information.

3.2 Quality Control Check

3.2.1 Equipment

3.2.1.1 Instrument (detector and/or readout)

3.2.1.2 Cables

3.2.1.3 Check source

3.2.1.4 Pulse generator (Ludlum Measurements, Inc. Model 500)

3.2.1.5 Calibration documents

3.2.1.6 Forms for Baseline Detector Response and Instrument QC Check

3.2.2 Procedure

3.2.2.1 This procedure is applicable to all field survey instruments.

3.2.2.2 Quality control checks are performed prior to sending instruments to the field, at the beginning and end of each day of data acquisition, upon return of the instrument from a field assignment, at any time instrument factors (batteries, cables, operating parameters, etc.) which could effect the instrument response are altered, and whenever the performance of an instrument is in question.

3.2.2.3 Assure that the baseline response has been established, that the response to the check source has been determined, and that the response was satisfactory (refer to Step 3.1.6).

3.2.2.4 All equipment associated with instrument operation (e.g., tubing, flow meters, collimators, headphones, etc.) should be in place when testing response to assure proper operation of the complete system.

3.2.2.5 Turn the instrument on and check batteries. Record result on Instrument QC check form; replace batteries and repeat test, if necessary.

3.2.2.6 Check high voltage, threshold, and other operating parameters; record values and, if necessary, adjust parameters to predetermined values and repeat checks. For some instruments it will be necessary to use the Ludlum Pulse Generator to determine and adjust the operating parameters.

3.2.2.7 Determine and record the instruments' baseline responses. The site-specific baselines will be determined at each site at a location selected by the Site Survey. Typical baseline instrument responses are as follows:

Table 2.1-1 Expected Baseline Instrument Responses

Instrument/Detector	Typical Baseline Response	Baseline Responses in Bridgeton Trailer
Ludlum Model 19	5 to 15 µR/h	5 to 7 µR/h
Bicron Microrem meter	3 to 10 µrem/h	-
Ludlum Mo 12 w/ Mo 44-2	700 to 2,400 counts/min	1,000 to 1,300 counts/min
Ludlum Mo 2221 w/ Mo 44-10	4,000 to 14,000 counts/min	4,000 to 5,100 counts/min
Ludlum Mo 2221 w/ Mo 44-20	7,000 to 23,000 counts/min	10,000 to 14,000 counts/min
Ludlum Mo12 w/ Mo 43-5	0 to 8 counts/min	0 to 5 counts/min
Ludlum Mo12 w/ Mo 44-9	20 to 60 counts/min	25 to 50 counts/min

3.2.2.8 Place the baseline check source in contact with the detector and determine and record the analog or integrated digital response, as appropriate. Calculate the net response and compare with the previously established acceptable baseline response range. If the source falls within that range, the instrument may be considered to be operating properly. If the response does not fall within the acceptable range, the instrument should not be used for quantitative measurements unless a thorough evaluation justifies otherwise.

3.2.2.9 If the instrument response to the baseline source is acceptable, select a QC check source and place the appropriate surface in contact with the designated location on the detector or instrument. Turn on the audible output to confirm its operation.

3.2.2.10 Where possible, for an analog readout instrument, select a scale on which the QC check source will provide a reading of between half- and full-scale; for an integrating digital readout instrument select a count time which will result in accumulation of at least 10,000 counts. Determine and record the gross and net instrument response on the appropriate form. For instruments that will be operated in the scaler mode, repeat the determination ten times and calculate the average; one reading is recorded for instrument to be operated in the ratemeter mode. Calculate and enter the range of acceptable instrument response as the average ± 20%.

3.2.2.11 To check response of the instrument, relative to the predetermined acceptable QC response range, place the source at the designated source test position and determine and record the analog or integrated digital response, as appropriate. Calculate the net response and compare with the previously established acceptable response range. If the source falls with that range, the instrument may be considered to be operating properly. If the response does not fall within the acceptable range, data recorded since the previous acceptable test should be considered questionable, and not used for quantitative purposes, unless a thorough evaluation justifies otherwise.

PROCEDURE 2.3
DIRECT RADIATION MEASUREMENT

1.0 PURPOSE

1.1 To describe the method for measuring total alpha and beta radiation levels on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Ratemeter-scaler: Model 3, Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent

3.1.2 Detector: Selected detectors are listed below: Equivalent detectors are also acceptable

Activity	Detector Type	Model
alpha	ZnS scintillator	Ludlum 43-1 or 43-5, Eberline AC3-7 or AC3-8
	gas proportional	Ludlum 43-68
beta	Geiger-Mueller	Ludlum 44-9, Eberline HP-260
	gas proportional	Ludlum 43-68

3.1.3 Cables

3.1.4 Check source

3.1.5 Record forms

3.2 Quality Control Check

3.2.1 Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and check source responses. Follow the procedures described in Procedure 2.1.

3.3 Direct Measurement

3.3.1 When applicable, team members performing instrument checks will calculate the average and maximum "field action levels" for instrument combination based on the specific site criteria and background.

Action level (cpm) = [site criteria (dpm/100 cm^2) x E x G x T] + B

T = count time (minutes)
E = operating efficiency (counts/disintegration)
G = geometry (total detector area (cm^2)/100)

	Total Area	Active Area
43-5 detector area =	80 cm^2	60 cm^2
43-1 detector area =	80 cm^2	50 cm^2
43-68 detector area =	126 cm^2	100 cm^2
44-9 detector area =	20 cm^2	15.5 cm^2
HP-260 detector area =	20 cm^2	15.5 cm^2

B = background (cpm)

A field count at or above this value indicates that further investigation in this location is necessary.

NOTE: For a particular site, the action level may be established as any activity exceeding background.

3.3.2 Select an appropriate counting time. A counting time is desired which will achieve a minimum detectable activity (see Procedure 4.2) value less than 50% of the applicable criteria. For most radionuclides a 1-minute count, using the instruments listed above, is adequate to achieve this sensitivity. For radionuclides having guidelines of 5000 dpm/100 cm^2, average and 15,000 dpm/100 cm^2, maximum, 0.5 minute counting times may be acceptable.

3.3.3 Place the detector face in contact with the surface to be surveyed. The detector face is typically constructed of a very thin and fragile material, so care must be exercised to avoid damage by rough surfaces or sharp objects. (Scans should have been performed, prior to this point, to identify representative locations and locations of elevated direct surface radiation for measurement.)

3.3.4 Set the meter timer switch, press the count-reset button, and accumulate the count events until the meter display indicates that the count cycle is complete.

3.3.5 Record the count and time on the appropriate record form.

3.3.6 If the location has a surface activity level above background, the area around the measurement locations should be scanned to determine the homogeneity of the measured activity level in the area. Dimensions and activity levels of inhomogeneities should be documented on the appropriate record form.

3.3.7 The surface activity may be calculated according to Procedure 4.3.

PROCEDURE 2.6
SUBSURFACE SCANNING (BOREHOLE LOGGING) AND SAMPLING

1.0 PURPOSE

1.0 To describe the method for performing subsurface sampling and vertical scanning.

1.1 Subsurface scanning indicates locations and relative levels of radioactivity.

2.0 RESPONSIBILITIES

2.0 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.1 Survey team members are responsible for following this procedure.

3.0 MATERIALS

3.1 Instrumentation

3.1.1 Bicron microrem meter or comparable tissue equivalent dose meter.

3.1.2 Portable ratemeter-scaler: Model 3, Model 12, Model 2241 or Model 2221 Ludlum Measurements, Inc.; or equivalent.

3.1.3 Sodium iodide detector: Model 44-2, Ludlum Measurements, Inc.; Model SPA-3 or PG-2, Eberline Instrument Corporation; or equivalent.

3.1.4 Cables of sufficient length to reach the bottom of the deepest borehole.

3.2 Supplemental Equipment

3.2.1 Light rope or cable of sufficient strength and length to lower detector to the bottom of the deepest borehole and retrieve it. Rope should be clearly marked in 6-inch (15-cm) increments.

3.2.2 Clamp or tape to secure rope to detector.

3.2.3 Optional lead collimator for scintillation probe. Collimator design based on specific project needs.[1]

3.2.4 Optional winch assembly for lowering and raising detector in deep boreholes.

3.2.5 Plastic (PVC) pipe, as required, of sufficient length and diameter to encase borehole to the desired logging depth. The pipe diameter will be determined by the dimensions of the drill bit or soil probe.

For example, a 2-inch I.D. (internal diameter) Schedule 40 PVC pipe is recommended for most applications involving a Model 44-2 (1-inch

[1] NOTE: Borehole logging can be done using a bare or collimated NaI detector. Uncollimated detectors are used for shallow or small diameter boreholes or for collecting general information concerning the vertical distribution of radioactive material in the borehole. Therefore, depending on the specific needs of the survey, items 3.2.3 and 3.2.4 are optional and are typically used for boreholes measuring 3 meters or greater in depth.

sodium iodine) detector. This size pipe requires installation of a 2.5 inch diameter or larger borehole.

3.2.6 One PVC pipe end cap for each planned borehole, plus at least two extra end caps for contingencies.

3.2.7 PVC Pipe cement.

3.2.8 A saw or PVC pipe cutter to size PVC pipe lengths.

3.2.9 Plastic bags large enough to cover detector assembly when down hole.

3.2.10 Record forms and pens.

3.2 Boring Equipment

3.2.1 Geoprobe with 3.25 inch sampling barrel and tool string.

3.2.2 Enough tube inserts for the 3.25 inch barrel to accommodate planned sampling at all locations and depths with extra for wastage.

3.2.3 Two tube caps for each insert.

3.0 INSTRUMENT ASSEMBLY

3.1 Assemble instrument/detector combination with long cable.

3.2 Securely attach support rope to detector. Use tape or wire ties to secure cable to support rope at approximately 1-meter intervals. Leave about 1-2 inches of slack in cable between the top of the detector and the first piece of tape or wire tie binding the rope to the cable.

NOTE: The weight of the detector should always be supported by a rope or equivalent. The detector should NEVER be lifted or supported by the long instrument cable.

3.3 Perform daily instrument check on assembled unit as described in Procedure 2.1.

4.0 SITE PREPARATION PRIOR TO INSTALLATION OF A BOREHOLE

4.1 Refer to the Project Sampling Plan for the location of selected borehole.

4.2 (Optional) Have a licensed surveyor locate and clearly mark all sampling locations

4.2 Proceed to selected borehole location and record its coordinates using GPS coordinates and a unique borehole description or identification number.

4.3 Using a microrem meter, collect and record the dose rate, in mrem/h, at 1-meter above the ground.

4.4 Using the selected meter and detector combination (see 3.0, above), collect and record a 30 second measurement, in cpm, at 1 centimeter (~0.5 inch) above the ground.

5.0 SUBSURFACE SAMPLING PROCEDURE

5.1 USING A GEOPROBE

5.1.1 Position GeoProbe with a 3.25 inch soil probe (e.g. barrel) over the desired location of the borehole.

5.1.2 Collect the first soil core from hole.

5.1.3 Extract the tube liner containing soil core from the coring tool and cap the liner's ends. Seal the ends with electrical tape.

5.1.4 Use indelible ink to mark each liner with a) an arrow pointing to the top of the soil sample, b) the unique location identifier, and c) an estimate of the sample depth interval recovered (For example: ←Top, NSU#1, 0-22 inches).

5.1.5 Use the Geoprobe to collect the next soil core from the hole.

5.1.6 Extract the tube liner containing soil core from the coring tool and cap the liner's ends. Seal the ends with electrical tape.

5.1.7 All tubes containing soil must be handled and stored in the vertical position with the top up.

5.1.8 Use indelible ink to mark each liner with a) an arrow pointing to the top of the soil sample, b) the unique location identifier, and c) an estimate of the sample depth interval recovered (For example:←Top, NSU#1, 23-41 inches).

5.1.9 If required, soil tubes can be scanned by a variety of instruments after they are sealed and properly labeled. If this is required, the instruments and scanning method will be specified in project specific documentation.

5.1.10 Labeled sample tubes containing soil can be stored in an upright 85 gallon drum until soil sample depths are identified from logging data.

5.11 Continue repeating steps 5.5 and 5.9 until the desired depth is reached or until refusal.

5.12 Once borehole sampling is complete, cut PVP pipe to a length that is equal to the depth of the borehole plus about 4 inches and glue one end-cap on PVP pipe. Place PVP pipe into hole (end cap on bottom and open end up). Push PVP pipe into hole until pipe is firmly seated in hole.

5.13 Move the Geoprobe to next hole.

5.2 USING A HAND AUGER

5.2.1 Position auger (using a 3 inch diameter soil bucket) over the desired location of the borehole.

5.2.2 Collect the first 6" of soil from hole.

5.2.3 Empty auger bucket into a bag lined 5 gallon bucket (or equivalent) marked with 0-1'.

5.2.4 Retrieve next 6" soil increment from hole and place in the 0-1' bucket.

5.2.5 Decon auger bucket between each 1' increment.

5.2.6 Using the same method for each 6" increment, empty each 1 foot increment into a uniquely identified bag lined 5 gallon bucket corresponding to that particular depth.

5.2.7 If required, 5 gallon buckets can be scanned by a variety of instruments after all properly labeled buckets are transported to the sample preparation area. If this is required, the instruments and scanning method will be specified in project specific documentation.

5.2.8 Continue repeating steps 5.2.5 through 5.2.7 until the desired depth is reached or until refusal.

5.2.9 Once borehole sampling is complete, cut a PVP pipe (or equivalent) to a length that is equal to the depth of the borehole plus about 4 inches and glue one end-cap on PVP pipe. Push PVP pipe into hole until pipe is firmly seated in the hole (end cap on bottom and open end up).

5.2.10 Survey the sampling equipment and decon with water as needed. Move the auger equipment to next hole.

5.2.11 Perform a gamma log of the borehole (see Section 7).

5.2.11 Remove PVC pipe from hole and backfill hole if required.

6.0 DOWNHOLE LOGGING PROCEDURE

6.1 Prior to inserting the detector down-hole, enclose the detector assembly, including the collimator if in use, in double plastic bags or tubular sheeting to protect detector against direct contact with water or soil from the borehole.

6.2 Set the scaler timer to accumulate counts over a period of 0.5 or 1 minute, depending upon contaminant and ambient detection level.

6.3 (Optional) If using the winch assembly, place it over the borehole.

6.4 Position the detector over the hole with bottom of the detector level with the ground surface. If using the collimator assembly, position the slots level with the ground surface.

6.5 Record this initial position as the 0 centimeter or surface measurement. If using the collimator assembly, reset the depth recorder to 0. Collect the first timed measurement and record the results, in cpm, at this position.

6.6 Lower the detector slowly into the borehole, stopping at 6 inch intervals to collect and record timed measurements in cpm. Record the depths of these locations.

6.7 When the detector reaches the bottom of the borehole or borehole liner pipe record the last measurement and depth of the hole.

6.8 Raise the detector to the surface and inspect the detector for signs of water infiltration into the plastic cover. Clean the cover or replace it, as needed.

7.0 COLLECTION OF SOIL SAMPLES

7.1 FROM GEOPROBE SOIL TUBES

7.1.1 Once downhole logging is complete, the series of downhole radiation measurements from that borehole will be analyzed and a number of samples may be extracted from the soil tubes. The number and depths of these samples will be determined by the sampling plan or the supervisor of the sampling task.

7.1.2 The sample depth will generally be determined as the sum of the recovered soil in the sampling tubes, not the length of the plastic tube containing the soil.

7.1.3 Soil samples will be processed as described in Procedures 2.8 (preparation of Transportation, 3.3 (Soil Sampling), and 3.7 (Sample Identification).

7.2 FROM AUGERED SOIL IN BUCKETS

7.2.1 Once downhole logging is complete, the series of downhole radiation measurements from that borehole will be analyzed and a number of samples may be extracted from the plastic-lined buckets holding the soil samples collected at specific depth. The number and depths of these samples will be determined by the sampling plan or the supervisor of the sampling task.

7.2.2 Soil samples will be processed as described in Procedures 2.8 (preparation of Transportation, 3.3 (Soil Sampling), and 3.7 (Sample Identification).

PROCEDURE 2.7
MONITORING PERSONNEL AND EQUIPMENT FOR RADIOACTIVE CONTAMINATION

1.0 PURPOSE

1.1 To describe the general approach for monitoring personnel and equipment for radioactive contamination.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Upon exiting potentially contaminated areas, monitoring of clothing and exposed skin surfaces will be performed. Equipment and materials will also be monitored and shown to be free of contamination before release for use without radiological restrictions or controls.

3.2 Equipment

3.2.1 Ratemeter-scaler: Model 3 or Model 2221, Ludlum Measurements, Inc.; or equivalent, equipped with audible speaker or headphones.

3.2.2 Detector: Selected detectors are indicated below. Equivalent detectors are also acceptable.

Activity	Detector Type	Model
Alpha	ZnS scintillator	Ludlum 43-1 or 43-5, Eberline AC3-7 or AC3-8
	Gas proportional	Ludlum 43-68, Ludlum 239-1
Beta	Gas proportional	Ludlum 43-68, Ludlum 239-1
	Geiger-Mueller	Ludlum 44-9, Eberline HP-260

3.2.3 Instrument cables

3.2.4 Check sources

3.2.5 Record Forms and/or field logbook

3.3 Quality Control Check

Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and source responses following Procedure 2.1.

3.4 Surface Scanning

3.4.1 Headphones or other audible signal operating modes are used for scanning.

3.4.2 Set the instrument response for "FAST", response where possible.

3.4.3 Pass the detector slowly over the surface. The detector should be kept as close to the surface as conditions allow. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor. While scanning for alpha or beta activity, the detector is typically moved about one detector width per second.

3.4.5 Note increases in count rate as indicated by the audible meter output. Identifiable increases in the audible response suggest possible contamination and should be resurveyed at a slower rate to confirm findings.

3.5 Personnel Monitoring

3.5.1 When monitoring for skin or clothing contamination, give particular attention to the hands, shoes, pant and shirt cuffs, knees, and other surfaces which have a high likelihood of contamination.

3.5.2 If there is detectable contamination, it should be removed as directed by the Health and Safety Committee (HSC) Chairperson. Decontamination guidance will be provided in the Survey Work Plan. The Site Safety Officer will implement decontamination or other contamination control actions at the project site.

3.6 Equipment Monitoring

3.6.1 For equipment surveys, attention should be given to monitoring cracks, openings, joints, and other areas where contamination might accumulate.

3.6.2 Measure levels of total and removable surface contamination (see Procedures 2.3 and 3.6) at locations of elevated direct radiation identified by the scan and at additional representative surface locations.

3.6.3 Acceptable surface contamination levels will be established on a project-specific basis, with details, including decontamination instructions, provided in the Survey Work Plan.

3.7 Document results of contamination surveys in field records.

PROCEDURE 2.8
PREPARING SAMPLES FOR TRANSPORTATION

1.0 PURPOSE

1.1 To provide guidance for preparing samples for transportation to assure regulatory compliance.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

2.3 The Health and Safety Committee will assist in preparing appropriate criteria for potential shipments, including specific radiation action levels at appropriate distances from the container's surface.

3.0 PROCEDURE

3.1 Overview of regulations: Regulations for transportation of samples containing small quantities of radioactivity are set forth in 49 CFR 173, Subpart I. The regulations take a graded approach, and shipments containing greater radioactivity will generally be required to follow more stringent shipping requirements

For transportation purposes, radioactive material is defined in 49 CFR 173.403 as "… any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in the table in §173.436 or values derived according to the instructions in §173.433." These activities are reproduced in Table 2.8-1 for a subset of radionuclides.

It is important to note that 49 CFR 173.401(b)(4) states that Subpart I does not apply to "…(n)atural material and ores containing naturally occurring radionuclides which are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed 10 times the values specified in §173.436."

3.2 Applicability and Additional Considerations: For the purpose of shipping, most samples collected from environmental media, are expected to be either excepted, or classified as non-radioactive for shipping purposes. If the sample shipment exceeds the limits specified in Table 2.8-1, this procedure does not apply, and special handling will be required.

In addition to requirements imposed by transportation regulations, the analytical laboratory or other receiver of the shipped samples may have further restrictions or requirements which must be considered in preparation of the shipment.

The Health and Safety Committee will assist in preparing appropriate criteria for potential shipments, including specific radiation action levels at the container surface, at 30 cm from the surface, and at 1 m from the surface. Special packaging and labeling instructions will also be developed. This information will be incorporated into the Survey Work Plan.

3.3 The following is the process for preparing samples for transportation:

3.3.1 Select an appropriate outer container for the samples. The container must be strong and capable of retaining contents during conditions normally incident to transportation. A typical container used by A&A is a 48 quart plastic cooler.

3.3.2 Place a plastic liner inside the container. A plastic garbage bag works well.

3.3.3 Place the samples into the lined container. Do not exceed a net sample weight (including the individual sample containers) of 29 kg.

3.3.4 Scan the outside of the loaded container with a gamma detector (Procedure 2.2) to determine the location of the maximum radiation level.

3.3.5 Measure the radiation level (see Procedure 2.4) at a distance of 30 cm from the location on the container identified in Step 3.3. Record the results on the sample chain of custody form.

3.3.6 Compare the measurement obtained with the exposure rate action levels provided in the Survey Work Plan. If the radiation levels satisfy the criteria, the shipment is excepted from all manifesting and labeling requirements.[2] Contact the HSC Chairperson or the project manager if the package still does not meet the specified action levels.

3.3.7 Mark the outside of the inner lining with the UN identification number UN2910. This can be hand written using a black marker.

3.3.8 Fill spaces in the container liner with packing material to restrict sample movement during transport. If the container includes any freestanding

[2] For certain radionuclides, this concentration limit can be demonstrated by measurement of the direct radiation level associated with the package. For example, if the contaminant is oil-field NORM, calculations and experience have shown that the activity concentration limit will be satisfied if the direct radiation level at 30 cm from the package exterior (assuming a typical 48 quart cooler, used by A&A for sample shipping) is less than 20µR/h (or 20 µrem/h), above background. For other radionuclides, the relationship between concentration and direct radiation level may differ from that of Ra-226, and appropriate decision levels must therefore be established for each project.

liquids, include twice the sufficient absorbent material to absorb the liquid contents, in case of leakage.

3.3.9 Seal the inner plastic liner in a manner that leaves the UN number clearly visible.

3.3.10 Place the Chain-of-Custody form and other paperwork on top of the inner liner.

3.3.11 Close and seal the outer container.

3.3.12 Complete shipping papers. If the package is "Exempt", shipping papers are the same as if the shipment did not contain radioactive material.

3.3.13 Attach the shipping papers and initiate the shipment.

Table 2.8-1 Table of Exempt Material Activity Concentrations and Exempt Consignment Activity Limits Found in 49 CFR 173

Symbol of radionuclide [2]	Activity concentration for exempt material (pCi/g)	Parent radionuclide's average activity concentration in exempt package (pCi/g) [3,4]	Activity limit for exempt consignment (pCi)	Activity limit of parent radionuclide for exempt consignment (pCi) [3,4]
Am-241	27	27	2.7E+5	2.7E+5
C-14	2.7E+5	270000	2.7E+8	2.7E+8
Co-60	270	270	2.7E+6	2.7E+6
Cs-137 (b)	270	135	2.7E+5	1.4E+5
K-40	2700	2700 (27000)	2.7E+7	3E+7 (3E+8)
Pb-210 (b)	270	90 (900)	2.7E+5	9E+4 (9E+5)
NORM scale	270	30 (300)	2.7E+5	2E+4 (2E+5)
Ra-224 (b)	270	45 (450)	2.7E+6	5E+5 (5E+6)
Ra-226 (b)	270	30 (300)	2.7E+5	3E+4 (3E+5)
Ra-228 (b)	270	135 (1350)	2.7E+6	1E+6 (1E+7)
Rb(nat)	2.7E+5	3E+5 (3E+6)	2.7E+8	3E+8 (3E+9)
Sr-90 (b)	2700	1350	2.7E+5	1.4E+5
Th-228 (b)	27	4 (39)	2.7E+5	4E+4 (4E+5)
Th-230	27	27 (270)	2.7E+5	3E+5 (3E+6)
Th-232	270	135 (1350)	2.7E+5	1E+5 (1E+6)
Th (nat) (b)	27	3 (27)	2.7E+4	3E+3 (3E+4)
U (nat) (b)	27	2 (19)	2.7E+4	2E+3 (2E+4)
U (enriched to 20% or less)(g)	27	27	2.7E+4	2.7E+4
U (dep)	27	27	2.7E+4	2.7E+4

1 69 FR 3685, Jan 26, 2004

2 +D indicates the sum of the activities of the parent and specified daughters should be compared to exempt values

3 Derived values account for presence of daughters and incorporate 10x modifier for natural origin, if applicable.

PROCEDURE 3.3
SOIL SAMPLING

1.0 PURPOSE

To describe the procedures for collecting soil samples.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Digging implement: garden trowel, shovel, spoons, post-hole digger, etc

3.2 Special sampling apparatus (cup cutter, shelby tube, metal or plastic tube, etc.) as required

3.3 Drilling equipment: drilling rig, portable motorized auger, manual auger

3.4 Subsurface sampling apparatus: split-spoon sampler, shelby tube sampler

3.5 Sample containers

3.6 Tape

3.7 Indelible pen

3.8 Labels and security seals

3.9 Equipment cleaning supplies, as appropriate

3.10 Record forms and/or logbook

4.0 PROCEDURE

4.1 NOTE: Typically, soil contamination criteria for radionuclides are applicable to the average concentration in 15 cm layers of soil, therefore, the sampling protocols described here are based on sampling 15 cm increments. The method used to sample soil will depend on the specific application and objective. Therefore, several techniques are described in this procedure and selection will be on a site-specific basis. Special situations (e.g., evaluating trends or airborne deposition, determining near-surface contamination profiles, and measuring non-radiological contaminants, necessitate special sampling procedures. These special situations are evaluated and incorporated into site specific survey plans as the need arises.

4.1.1 Direct surface and 1 meter gamma radiation measurements may be performed at each location before initiating sampling. This will identify the presence of gross radionuclide contamination that will require special handling and equipment cleanup procedures. If contamination is suspected, a beta-gamma "open" and "closed" measurement may also be desired before sampling begins.

4.2 Surface Soil

4.2.1 Loosen the soil at the selected sampling location to a depth of 15 cm, using a trowel or other digging implement.

4.2.2 Remove large rocks, vegetation, and foreign objects (these items may also be collected as separate samples, if appropriate).

4.2.3 Place approximately 1 kg of this soil into the sample container. If it is not possible to reach a depth of 15 cm using a hand tool (i.e. trowel or shovel) 1 kilogram of soil should be collected from the accessible depth. The actual depth should be recorded on the sample container and the appropriate record form.

4.2.4 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie the sample bag strings).

4.2.5 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.2.6 Record sample identification, location, and other pertinent data on appropriate record forms, maps, drawings, and/or site logbook.

4.2.7 If the location has been identified as having elevated activity, a measurement should be obtained after the sample is collected to determine the possibility of contamination at a depth greater than 15 centimeters. If a subsurface sample is deemed necessary, refer to the appropriate section below.

4.2.8 Clean sampling tools, as necessary, according to the procedure in the Quality Assurance Plan, before proceeding with further sampling.

4.3 Subsurface Soil (Option 1)

4.3.1 Procedure applicable to depths of approximately 3 m when boreholes or trenches have been dug and remain uncollapsed or do not contain water.

4.3.2 When direct radiation measurements are required (surface and borehole logging) they are to be performed prior to sample collection in order to identify the presence of gross radionuclide contamination requiring special handling or cleanup (see the Quality Assurance Plan and/or Health and Safety Plan). If borehole logging is to be done it should be completed before sampling begins (see Procedure 2.6).

4.3.3 Place a plastic bag liner into the downhole sampler and secure with a large rubber band.

4.3.4 Lower the sampling tool to the desired depth in the borehole or trench.

4.3.5 Scrape the inside borehole or trench wall with the toothed edge of the tool until approximately 1 kg of sample is collected.

4.3.6 Transfer the plastic bag and sample into the container.

4.3.7 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie sample bag ties).

4.3.8 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.3.9 Record sample identification, location, depth, and other pertinent data on the appropriate record forms, map, drawing, and/or site logbook.

4.3.10 Clean sampling tools, as necessary, in accordance with instructions in the Quality Assurance Plan, before proceeding with further sample collection.

4.4 Fixed Geometry and Subsurface Soil (Option 2)

4.4.1 This procedure is appropriate for sampling at depths exceeding 3 m, in boreholes where walls do not remain intact or that fill with water and in situations where it is necessary to retain the orientation of the sample. An example where the latter may be the case, would be when it was necessary to analyze segmented aliquots to determine radionuclide concentrations as a function of depth. This approach could incorporate surface sampling as well as subsurface sampling.

4.4.2 If necessary, drill the borehole to the desired sampling depth using an auger.

4.4.3 Drive a split-spoon, shelby tube, or similar design sample collector through the specified sampling depth.

4.4.4 Withdraw the collecting device; the collected core may be removed at this time.

4.4.5 If the collected core is removed, place the entire core, or a portion of the core, into a sample container. The core may be split into multiple segments, representing different sampling depths. If the core is to remain in the sampling device, the ends are sealed and the orientation noted.

4.4.6 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.4.7 Record sample identification, location, depth, and other pertinent data on the appropriate record forms, map, drawing, and/or site logbook.

4.4.8 Monitor the sample hole to determine activity level. If the activity level is elevated, it may be desirable to repeat items 4.4.1- 4.4.6. If the activity level has dropped to background, record the measurement and monitor the area, including personnel and equipment, to determine the extent of decontamination that may be necessary.

4.4.9 Clean sampling tools, as necessary, in accordance with instructions in the Quality Assurance Plan, before proceeding with further sample collection.

PROCEDURE 3.6
REMOVABLE ACTIVITY SAMPLING

1.0 PURPOSE

1.1 To provide guidelines for measuring removable alpha and beta radioactivity on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment and Materials

3.1.1 Smears, Mazlin wipes, filter papers (like Whatman 47 mm dia. glass fiber) or equivalent

3.1.2 Glassine or paper envelopes

3.1.3 Record forms

3.1.4 Counting equipment

3.2 Sample Collection

NOTE: Direct measurements will be completed before a smear sample is taken.

3.2.1 Grasp the smear (filter) paper by the edge, between the thumb and index finger.

3.2.2 Applying moderate pressure with two or three fingers, wipe the numbered side of the paper over approximately 100 cm^2 of the surface.

3.2.3 Place the filter in an envelope.

3.2.4. Record the smear number, site, date, location of the smear, and name of sample collector on the envelope.

3.2.5 Label and secure in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

3.2.6 If the direct measurement was elevated, the smear should be monitored (procedures 2.2 and 2.3) to determine whether contaminated material was transferred to the smear. If an activity level greater than 250 cpm is detected, the smear envelope should be marked as such.

NOTE: Smears having activity levels greater than 2500 cpm should be counted using field instrumentation. Decisions regarding further analyses and method of disposal of contaminated smears will be made by the PM and SSM on a case-by-case basis.

3.3 Field Sample Measurement

3.3.1 If the object of the survey is to determine if radon or thoron daughter products or other short half-life radionuclides are present, the smears should be counted within 1-2 hours before significant decay of short-lived radionuclides has occurred.

3.3.2 If necessary, smears can be counted in the field using portable instrumentation (see Procedure 2.3).

3.3.3 Record count and counting time data on the appropriate record form.

3.3.4 Subtract the background count (determined by counting blank or unused smear) and convert net count to dpm/100 cm^2, using proper time and detector efficiency values.

$$\frac{DPM}{100\,CM^2} = \left(\frac{NETCOUNT}{TIME(\mathrm{MIN}) * EFFICIENCY * \left(\frac{COUNT}{DISINTEGRATION} \right) * OTHERMODIFIYINGFACTORS} \right)$$

PROCEDURE 3.8
SAMPLE CHAIN-OF-CUSTODY

1.0 PURPOSE

To provide a method for sample chain-of-custody.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

Chain-of-custody is initiated upon collection (or receipt) of samples and continues until samples are transferred to another organization or are disposed. An acceptable chain-of-custody is maintained when the sample is under direct surveillance by the assigned individual; the sample is maintained in a tamper-free container; or the sample is within a controlled-access facility. The chain-of-custody is recorded on a standardized A&A form (see Appendix A) or a form provided by another organization, such as an analytical laboratory or another sampling agency.

3.1 Field Procedures

3.1.1 An individual present during sample collection is designated as the sample custodian and is responsible for maintaining surveillance of the sample until the custody of that sample is transferred to another party. Samples must, at all times, be in the possession and under the direct surveillance of the sample custodian, or secured in a locked vehicle, building, or container. The sample custodian initiates a chain-of-custody form, daily, for all samples collected or received on that day.

3.1.2 Samples may be listed on the form as an individual entry or group of samples having common characteristics and originating from the same site may be recorded as a single entry, provided information describing each sample in the group (e.g. a completed field data form) is attached to or referenced on the custody form.

3.1.3 If sample custody is to be transferred (relinquished), the container and its contents are inspected by the individual accepting custody to assure that tampering has not occurred and custody has therefore been maintained. If evidence of tampering is observed or if any deviations or problems are noted, a notation must be provided on the form by the individual accepting custody. The sample collector must sign the first "Relinquished by" block and the receiver must complete the first "Received by" block.

3.1.4 If sample custody will not be assured under one of the conditions in item 3.0 above, a security seal is placed on the container of the samples. A security seal is a wire, tape, or other such item, which is uniquely identified (numbered), and can be affixed to a package in a manner as to require damaging the seal if the package is opened. Damage to the seal thereby alerts the recipient of a package to the possibility of tampering with the contents. The number of the seal is entered onto the Chain-of-Custody form. Samples, which are under security seals, do not have to be maintained in a secure area; however, precautions should be taken to restrict sample access to authorized individuals.

3.1.5 The original of the chain-of-custody form must contain all signatures and other pertinent records regarding custody. Therefore the original is retained in the possession of the individual who has custody.

3.1.6 As long as samples remain in custody of the sampler, both copies of the chain-of-custody form are to accompany the samples. If custody is transferred to another individual and the control requirements in item 3.0 above are not satisfied, the duplicate copy of the form is packaged with the samples and the original remains with the individual having custody.

3.1.7 Samples collected by other organizations and provided to A&A personnel will have chain-of-custody initiated for them by the individual receiving the samples. When the organization has an established chain-of-custody in place, a copy of the form will be attached to the A&A form.

3.2 Sample Transport

3.2.1 Samples must comply with regulations of the Department of Transportation, if they are to be transported over or through publicly accessible transport routes. The Health and Safety Plan describes the procedure for assuring compliance with this requirement.

3.2.2 Unsealed samples may be transported by a vehicle controlled by the person having custody of the samples, or in that person's hand carried baggage.

3.2.3 Transport by mail, checked baggage, common carrier, or other mode not controlled by the sample custodian of record, requires that security seals be used.

3.2.3 The method of transport is to be identified on the original chain-of-custody record. If inner containers are sealed, additional seals on outer packaging are not required.

3.3 Samples sent to other organizations

3.3.1 The custodian will sign the "Relinquished by" space and the original form will be packed with the samples.

3.3.2 Receiving organizations will be requested to check the container and its contents for signs of tampering and note any deficiencies in the "Comments" portion of the form.

3.3.3 When samples will not be returned to A&A, the receiving organization will be asked to return the original of the form. The form will be provided to the Project Manager, for inclusion with the project records.

3.3.4 If samples will be returned to A& A, the receiving organization will be asked to sign the "Relinquished by" space and pack the form with the samples for return shipment. Upon receipt, the samples and form will be provided to the Project Manager, who will sign the "Received" space and place a copy in the project file.

Appendix B

Eberline Services Oak Ridge Laboratory Quality Assurance Program Manual

Eberline Analytical
Oak Ridge Laboratory
Quality Assurance Program Manual

AUTHORIZATION AND APPROVAL STATEMENT

This **Eberline Analytical** - Oak Ridge Laboratory,
ñQuality Assurance Program Manualò
is authorized and approved in its entirety by:

____
Saba Arnold Seaver
Quality Assurance Manager

Date: August 1, 2013

____
Michael R. McDougall
Laboratory Manager

Date: August 1, 2013

Eberline Services – Oak Ridge Laboratory
601 Scarboro Road
Oak Ridge, TN 37830
Phone: (865) 481 - 0683, Fax: (865) 83 - 4621

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MISSION STATEMENT

Our mission is to ensure that all of The Eberline Services, Oak Ridge Laboratory's systems, services, processes, and deliverables are of a quality that meets or exceeds client requirements; and to foster a Laboratory culture in which there is a commitment to a rising standard of quality. This culture demands that the quality of those systems, services, processes, and deliverables and the methods used to achieve that quality be continuously improved.

Quality Assurance is a spirit that pervades all aspects of an organization. It is the quality attitude developed by a quality culture in an organization. It is the spirit in which any organization, procedure or activity is documented, implemented and performed. This spirit produces empowerment and motivation in all employees to achieve the highest level of quality. The result of this attitude is **"Quality Assurance."**

The policy guidelines are presented in this Oak Ridge Laboratory Quality Assurance Program Manual, and are based on the philosophy and premises that:

- People are our greatest asset and are ultimately responsible for the quality of the items and services we provide. Therefore, each person is treated with the greatest possible respect and consideration.
- Employees are inherently proud and want to produce top quality and on time services and deliverables. In order to do this they must be made aware of the quality requirements that are expected and must be provided appropriate facilities, equipment, and proper training.
- A culture of quality embodied within the entire Oak Ridge Laboratory organization is the most effective way to provide support for the employee's commitment to quality.
- Management support is paramount, and organizational responsibilities must ensure integration of quality requirements in the day-to-day operations.
- All systems, services, processes, and deliverables can be planned, performed, assessed, and improved.
- Improvements allow operations to become more efficient and result in contractual requirements performed "on time" and done "right the first time."
- Quality improvements lead to reduced costs and allow the ultimate objective of providing the highest quality items and services to be a viable goal.

Quality is our clientọs perception of us. Our actions must assure our clients that the Oak Ridge Laboratory organization provides for quality systems, services, processes, and deliverables that will meet or exceed their requirements. To this end, each employee must understand and exercise the highest standards of ethics in the performance of their duties and ensure the integrity of the data they report.

STATEMENT OF COMPLIANCE AND MATRIX COMPARISON

This Quality Assurance Program Manual addresses the basic requirements outlined in several regulatory manuals, standards, regulations, and national laboratory programs. Matrix comparison to some of these documents is included in the following pages. Additional regulatory requirements are listed in Section 1.0.

NQA-Quality Assurance Requirements for Nuclear Facility Application
National Environmental Laboratory Accreditation Conference (NELAC), USEPA; 2003, the NELAC Institute (TNI), 2009
USEPA Requirements for the Certification of Laboratories Analyzing Drinking Water; 2005
ISO/IEC 17025 for the General Requirements for the Competence of Calibration and Testing
DOE Quality Systems for Analytical Services (QSAS) Document
DoD Quality Systems Manual for Environmental Laboratories (DoD QSM)
PJLA Accreditation Compliance Requirements

This manual is organized as follows:
ó
Name, Title, Authorization and Approval
Table of Contents
Mission Statement
Statement of Compliance and Matrix Comparison
Introduction and Description
Organization and Responsibility
Quality Assurance Objectives
Personnel Qualification and Training
Instructions and Procedures
Procurement Document Control
Material Receipt and Control
Material Storage and Control
Control of Process
Preventative Maintenance
Control of Measurement and Test Equipment
Data Reduction, Verification, and Reporting
Document Control
Internal Quality Control
Audits
Quality Assurance and Inspection Records
Corrective Action
Quality Assurance Reports to Management

MATRIX COMPARISON

NQA-1, Cross Reference to - Oak Ridge Laboratory Q.A. Program Manual

NQA-1- Quality Assurance Requirements for Nuclear Facility Applications (*Basic Requirements*)		**Oak Ridge, TN laboratory Quality Assurance Program Manual**	
BASIC RQMT	TITLE	QAM SECT	TITLE
1.	Organization	2.0	Organization and Responsibility
2.	Quality Assurance Program	3.0 4.0	Quality Assurance Objectives Personnel Indoctrination and Training
3.	Design Control	N/A	Does not apply
4.	Procurement Document Control	6.0	Procurement Document Control
5.	Instructions, Procedures, and Drawings	5.0	Instructions and Procedures
6.	Document Control	13.0	Document Control
7.	Control of Purchased Items and Services	7.0	Material Receipt and Control
8.	Identification and Control of Items	8.0	Material Storage and Control
9.	Control of Process	9.0	Control of Process
10.	Inspection	14.0	Internal Quality Control
11.	Test Control	14.0	Internal Quality Control
12.	Control of Measurement and Test Equipment	11.0	Control of Measurement and Test Equipment
13.	Handling, Storage, and Shipping	8.0	Material Storage and Control
14.	Inspection, Test, and Operating Status	14.0	Internal Quality Control
15.	Control of Nonconforming Items	8.0	Material Storage and Control
16.	Corrective Actions	17.0	Corrective Actions
17.	Quality Assurance Records	16.0	Quality Assurance and Inspection Records
18.	Audits	15.0	Audits
	N/A	N/A	Title Page
	N/A	N/A	Authorization and Approval Statement
	N/A	1.0	Introduction and Description
	N/A	10.0	Preventive Maintenance
	N/A	12.0	Data Reduction, Verification, and Reporting
	N/A	18.0	Quality Assurance Reports to Management

MATRIX COMPARISON

10 CFR Part 50, Appendix B Cross Reference to Oak Ridge Laboratory Q.A. Program Manual

NRC 10 CFR Part 50 Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."		**Oak Ridge, TN Laboratory Quality Assurance Program Manual**	
Criterion No.	TITLE	QAM SECT	TITLE
I	Organization	2.0	Organization and Responsibility
II	Quality Assurance Program	3.0	Quality Assurance Objectives
III	Design Control	N/A	Does not apply
IV	Procurement Document Control	6.0	Procurement Document Control
V	Instructions Procedures, and Drawings	5.0	Instructions and Procedures
VI	Document Control	13.0	Document Control
VII	Control of Purchased Material, Equipment, and Deliverables	7.0	Material Receipt and Control
VIII	Identification and Control of Materials, Parts, and Components	8.0	Material Storage and Control
IX	Control of Special Process	9.0	Control of Process
X	Inspections	14.0	Internal Quality Control
XI	Test Control	14.0	Internal Quality Control
XII	Control of Measuring and Test Equipment	11.0	Control of Measurement and Test Equipment
XIII	Handling, Storage, and Shipping	8.0	Material Storage and Control
XIV	Inspection, Tests, and Operating Status	14,0	Internal Quality Control
XV	Nonconforming Materials, Parts or Components	7.0	Material Receipt and Control
XVI	Corrective Actions	17.0	Corrective Actions
XVII	Quality Assurance Records	16.0	Quality Assurance Inspection Records
XVIII	Audits	15.0	Audits
		N/A	Title Page
		1.0	Introduction and Description
		10.0	Preventative Maintenance
		12.0	Data Reduction, Verification, and Reporting
		18.0	Quality Assurance Reports to Management

MATRIX COMPARISON

DOE Order 414.1**C** Cross Reference to Oak Ridge Laboratory Q.A. Program Manual

DOE Order 414.1 C "Quality Assurance"			**Oak Ridge, TN Laboratory Quality Assurance Program Manual**
Criterion No.	TITLE	QAM SECT	TITLE
1.	Program	1.0 2.0 3.0 12.0 13.0	Introduction Organization and Responsibility Quality Assurance Objectives Data Reduction, Verification, and Reporting Document Control
2.	Personnel Training and Qualification	4.0	Personnel Indoctrination and Training
3.	Quality Improvement	17.0	Corrective Actions
4.	Documents and Records	16.0 18.0	Quality Assurance Records Quality Assurance Reports to Management
5.	Work Process	5.0 9.0 10.0 14.0	Instructions and Procedures Control of Process Preventive Maintenance Internal Quality Control
6.	Design	N/A	Does not apply
7.	Procurement	6.0 7.0 8.0	Procurement Document Control Material Receipt and Control Material Storage and Control
8.	Inspection and Acceptance Testing	11.0 14.0 15.0	Control of Measurement and Test Equipment Internal Quality Control Audits
9.	Management Assessment	2.0	Organization and Responsibility
10.	Independent Assessment	15.0	Audits
N/A		N/A	Title Page
N/A		N/A	Authorization and Approval Statement

MATRIX COMPARISON

DOE Quality Systems (QSAS). And DoD Quality Systems (QSM) Cross Reference to Oak Ridge Laboratory QA Program Manual.

This cross reference applies also to NELAC Chapter 5.4.2.3

NELAC Chapter 5 "Quality Systems"		**Oak Ridge, TN Laboratory Quality Assurance Program Manual**	
4.2.6 RQMT	TITLE	QAM SECT	TITLE
	Title Page		Title Page
(a)	Policy statement, objectives, commitment by top management	1.0 3.0	Introduction and Description Quality Assurance Objectives
(b)	Organization and Management structure, Org Charts	2.0	Organization and Responsibility
(c)	Relationship between management, technical operations, support services and the quality system	2.0	Organization and Responsibility
(d)	Document control and records retention	16.0	Quality Assurance & Inspection Records
(e)	Job Descriptions	4.0	Personnel Indoctrination and Training
(f)	Approval signatories, signed concurrences	A&A	Authorization and Approval Statement
(g)	Traceability of measurements	14.0	Internal Quality Control
(h)	List of test methods	9.0	Control of Process
(i)	Review for facility and resource availability	9.0	Control of Process
(j)	Calibration or verification test procedures	5.0	Instructions and Procedures
(k)	Procedures for handling submitted samples	9.0	Control of Process
(l)	Major equipment and measurement standards	9.0 11.0	Control of Process Control of Measurement & Test Equipment
(m)	Calibration, verification, & maintenance	11.0	Control of Measurement & Test Equipment
(n)	Inter laboratory comparison, proficiency testing, reference material, internal Q.C.	14.0	Internal Quality Control
(o)	Corrective actions	17.0	Corrective Actions
(p)	Departures from policy/procedures	5.0	Instructions and Procedures
(q)	Complaints	1.0	Introduction and Description
(r)	Confidentiality and Proprietary rights	1.0	Introduction and Description
(s)	Audits and Data reviews	12.0 15.0	Data Reduction, Verification, and Reporting Audits
(t)	Personnel experience and training	4.0	Personnel Indoctrination and Training
(u)	Ethical and legal responsibilities	1.0	Introduction and Description
(v)	Analytical results reporting	12.0	Data Reduction, Verification, and Reporting
(w)	Table of Contents	TOC	Table of Contents

MATRIX COMPARISON

10 CFR Part 830.122 Cross Reference to Oak Ridge Laboratory Q.A. Program Manual

10CFR 830.122 "Quality Assurance Criteria"			**Oak Ridge, TN Laboratory Quality Assurance Program Manual**
Criterion No.	TITLE	QAM SECT	TITLE
830.122 (a)	Management/Program	1.0 2.0	Introduction Organization and Responsibility
(b)	Management/Personnel Training and Qualification	4.0	Personnel Indoctrination and Training
(c)	Management/Quality Improvement	3.0 14.0 17.0	Quality Assurance Objectives Internal Quality Control Corrective Actions
(d)	Management/Documents and Records	5.0 9.0 12.0 13.0 16.0 18.0	Instructions and Procedures Control of Process Data Reduction, Verification, and Reporting Document Control Quality Assurance Records Quality Assurance Reports to Management
(e)	Performance/Work Process	7.0 8.0 10.0 14.0	Material Receipt and Control Material Storage and Control Preventive Maintenance Internal Quality Control
(f)	Performance/Design	N/A	Does not apply
(g)	Performance/Procurement	6.0	Procurement Document Control
(h)	Performance/Inspection and Acceptance Testing	11.0 14.0 15.0	Control of Measurement and Test Equipment Internal Quality Control Audits
(i)	Assessment/Management Assessment	2.0	Organization and Responsibility
(j)	Assessment/Independent Assessment	2.0 15.0	Organization and Responsibility Audits
N/A		N/A	Title Page
N/A		N/A	Authorization and Approval Statement

MATRIX COMPARISON

EPA SW-846 Cross Reference to - Oak Ridge Laboratory Q.A. Program Manual

EPA SW-846 (Essential Elements)		Oak Ridge, TN Laboratory Quality Assurance Program Manual	
BASIC RQMT	TITLE	QAM SECT	TITLE
1.	Title Page	N/A	Title Page
2.	Table of Contents	N/A	Table of Contents
3.	Project Description	1.0	Introduction and Description
4.	Project Organization and Responsibility	2.0	Organization and Responsibility
5.	Q.A. Objectives	3.0	Quality Assurance Objectives
6.	Sampling Procedures	N/A	Does not apply to laboratory
7.	Sample Custody	9.0	Control of Process
8.	Calibration Procedures and Frequency	11.0	Control of Measurement and Test Equipment
9.	Analytical Procedures	5.0 9.0	Instructions and Procedures Control of Process
10.	Data Reduction, Validation, and Reporting	12.0	Data Reduction, Verification, and Reporting
11.	Internal Quality Control Checks	14.0	Internal Quality Control
12.	Performance and System Audits	15.0	Audits
13.	Preventive Maintenance	10.0	Preventive Maintenance
14.	Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completion	14.0	Internal Quality Control
15.	Corrective Action	17.0	Corrective Actions
16.	Quality Assurance Reports to Management	18.0	Quality Assurance Reports to Management
N/A		N/A	Authorization and Approval Statement
N/A		4.0	Personnel Indoctrination and Training
N/A		6.0	Procurement Document Control
N/A		7.0	Material Receipt and Control
N/A		8.0	Material Storage and Control
N/A		13.0	Document Control
N/A		16.0	Quality Assurance and Inspection Records

MATRIX COMPARISON

EPA QA/R-5 ñEPA Requirements for Quality Assurance Project Plansò

EPA QA/R-5, "EPA Requirements for Quality Assurance Project Plans"		Oak Ridge, TN Laboratory Quality Assurance Program Manual	
RQMT	**TITLE**	**SECT**	**TITLE**
A	**Project Management**		
A1	Title and Approval Sheet		Title Page Authorization and Approval (A&A) Statement
A2	Table of Contents		Table of Contents Page Headers (document control)
A3	Distribution List		Title Page
A4	Project/Task Organization	1.4 2.1 2.2 2.5	Introduction Organizational Structure Responsibility Organization Charts
A5	Problem Definition/Background	3.0 9.0 14.0	Quality Assurance Objectives Control of Process Internal Quality Control
A6	Project/Task Description	9.0	Control of Process
A7	Quality Objectives and Criteria	3.0	Quality Assurance Objectives
A8	Special Training/Certification	4.0	Personnel Indoctrination and Training
A9	Documents and Records	5.0 9.2 13.0 16.0	Instructions and Procedures Documented Procedures Document Control Quality Assurance and Inspection Records
B	**Data Generation and Acquisition**		
B1	Sampling Process Design (Experimental Design)	N/A	
B2	Sampling Methods	N/A	
B3	Sample Handling and Custody	14.4	Sample Custody
B4	Analytical Methods	5.0 9.0	Instructions and Procedures Control of Process
B5	Quality Control	14.0	Internal Quality Control
B6	Instrument/Equipment Testing, Inspection, and Maintenance	10.0 11.0	Preventive Maintenance Control of Measurement and Test Equipment
B7	Instrument/Equipment Calibration and Frequency	11.0	Control of Measurement and Test Equipment
B8	Inspection/Acceptance of Supplies and Consumables	7.0 8.0	Material Receipt and Control Material Storage and Control
B9	Non-direct Measurements	10.0	Data Reduction, Verification, and Reporting
B10	Data Management	10.0	Data Reduction, Verification, and Reporting
C	**Assessment and Oversight**		
C1	Assessments and Response Actions	15.0 17.0	Audits Corrective Action
C2	Reports to Management	18.0	Quality Assurance Reports to Management
D	**Data Validation and Usability**		
	Data Review, Verification, and Validation	12.0	Data Reduction, Verification, and Reporting

EPA QA/R-5, "EPA Requirements for Quality Assurance Project Plans"		Oak Ridge, TN Laboratory Quality Assurance Program Manual	
RQMT	**TITLE**	**SECT**	**TITLE**
D1		14.3	Data Verification
D2	Verification and Validation Methods	12.0	Data Reduction, Verification, and Reporting
D3	Reconciliation with User Requirements	12.0	Data Reduction, Verification, and Reporting

1.0 INTRODUCTION AND DESCRIPTION

1.1 PREFACE

Eberline Services ï Oak Ridge Laboratory is a radiochemistry laboratory that specializes in providing services for radiological assays to the environmental industry. Radionuclides are quantified within materials such as surface water, ground water, drinking water, wastewater, soil, sediment, sludge, vegetation, and hazardous waste. Bioassay (urine) analysis is performed for total uranium. The objective of the laboratory is to produce the highest quality data that are accurate, precise, legally defensible, and meet our clients data needs and requirements in a timely and cost effective manner.

The management of Eberline Services, Oak Ridge Laboratory is committed to a rigorous Quality Assurance (Q.A.) Program. While this commitment is necessary for the normal conduct of business, our basic policies dictate the highest standards of ethics and integrity in the conduct of our affairs. This philosophy and the specific procedures to attain policy objectives fromthe framework of our Q.A. Program. We will provide only those services that are within our qualifications and with confidence that our Q.A. Program and all related operating procedures dictate reliable performance of those services.

1.2 PURPOSE

This manual outlines management's Q.A. policy and establishes a requirement that procedures be promulgated and implemented to accomplish all of the quality assurance elements necessary to fulfill our responsibility to meet or exceed client or regulatory specifications. It also provides a means for creating mutual understanding regarding our Q.A. program and reliability techniques with our subcontractors, suppliers, and clients. This Eberline Services-Oak Ridge Laboratory Quality Assurance Program provides the structure, policies and responsibilities for the execution of quality control and quality assessment operations to assure that the laboratory meets defined standards of quality.

1.3 SCOPE

This Quality Assurance Program Manual provides guidance to meet operational Q.A. requirements.

In addition to the documents identified in the Cross Reference Section, this Manual complies with applicable requirements of the following the latest revisions of regulations below:

1.3.1 NRC 10 CFR Part 21, "Reporting of Defects and Non-compliance."

1.3.2 ANSI/ANS-10.3-, "Documentation of Computer Software.

1.3.3 NRC Regulatory Guide 4.15, Rev. 1, "Quality Assurance for Radiological Monitoring Programs - Effluent Streams and the Environment."

1.3.4 U.S. EPA QA/R-5, "EPA Requirements for Quality Assurance Program Plans."

1.3.5 DOE Order 414.1C ñQuality Assurance.ò

1.3.6 ISO/IEC 17025, "General Requirements for the Competence of Calibration and Testing Laboratories."

1.3.7 USEPA Directive 2185, ñGood Automated Laboratory Practicesò(GALP).

1.3.8 DOE Quality Systems for Analytical Services (QSAS)

1.3.9 DoD Quality Systems Manual for Environmental Laboratories (DoD QSM)

1.3.10 A National Environmental Laboratory Accreditation Conference (NELAC) Chapter 5 "Quality Systems", July 2003.

1.3.11 USEPA Manual for the Certification of Laboratories Analyzing Drinking Water, EPA 815-R-004, January 2005.

1.4 INTRODUCTION

Quality assurance, as outlined herein, is a tool that allows management to utilize the expertise and experience of all personnel on the job. It requires each worker to be aware of his/her work environment and to continually evaluate methods and processes to ensure that the best and correct operation is being performed. It requests each employee to identify and suggest any improvement to the processes while performing an operation. Improvements or changes shall be coordinated with management who will validate improvement and disseminate the information to all affected personnel. Management shall also, as needed, change procedures and provide additional training. This program also requires that all personnel be qualified, and trained on a continuing basis to maintain that qualification and be assimilated into the Oak Ridge Laboratory quality culture.

Management will provide resources, tools, equipment, scheduling, and training to ensure personnel can perform their duties effectively.

1.4.1 Management will also ensure that internal assessments are performed annually to evaluate management and processes with feedback for review with a goal of improving all areas of operations.

1.4.2 It is only by having a quality assurance culture, with all personnel involved, that a system, service, or product can be provided with full assurance that the best possible work, the best possible product, or the best possible service has been provided.

1.4.3 In order to ensure that this manual is an effective management tool, subjects that are not normally considered quality assurance, i.e. safety, security, etc., are addressed in other management documents.

1.4.4 The following titled designations of positions are used within the Oak Ridge, TN Laboratory:

Laboratory Manager: Refers to the General Manager of the Oak Ridge Laboratory.

Radiation Safety Officer (RSO): Refers to the RSO of the Oak Ridge Laboratory.

Emergency Coordinator: Refers to the individual who is responsible for overseeing and directing activities and protocols associated with emergencies and disasters..

Project Manager: Refers to an individual who is responsible for client service activities and is the single point of contact with a client for the laboratory.

Supervisor: Refers to individuals within the laboratory who are responsible for the operational functions of a group of personnel.

Q.A. Manager: Refers to the individual who is responsible for the Laboratory's Q.A.

Program.

1.5 DESCRIPTION

This document outlines the organization of the Q.A. functions within the laboratory. It depicts the lines of authority, and lists the duties and responsibilities within the organization. It provides direction for the preparation of Procedures Manuals, which provide the detailed methods of processes and analyses that accomplish the goal of quality data in terms of precision, accuracy and reproducibility.

1.6 CONFIDENTIAL AND PROPRIETARY INFORMATION

Oak Ridge Laboratory employees are exposed to confidential and/or proprietary information pertaining to the company and its clients. Information concerning the report of analysis, radiation dosimetry records, audit reports, calibration reports, and other documents relating to a project are considered confidential. This information is to be released only to the client or to the client's authorized representative. Each employee will sign an agreement with the Oak Ridge, TN Laboratory concerning the security of proprietary and confidential information. A copy of the agreement will be retained in the employee's personnel file (at the corporate office in Albuquerque, NM).

1.7 TECHNICAL COMPLAINTS

Technical complaints will be addressed by the Laboratory Manager, Project Manager, Quality Assurance Manager, or staff member with expertise in the area of complaint. If the complaint is not valid, every attempt will be made to satisfy the client. If the complaint is determined to be valid, the cause of the complaint shall be identified and corrected as soon as feasible. Verification that the cause for a valid complaint has been corrected is the responsibility of the individual addressing the complaint. Details of all technical complaints shall be recorded and maintained in the customer's project file. Clients are also encouraged to provide feedback on the Eberline Analytical website via a statement on each client report.

1.8 ETHICAL AND LEGAL RESPONSIBILITIES

Eberline Services-Oak Ridge Laboratory utilizes a clearly stated ethics policy that is discussed with all new employees during orientation. Each employee is required to understand the high standards of ethics and integrity required in order to perform their duties and to ensure the integrity of the data reported in connection with their employment at the Oak Ridge Laboratory. Each employee will understand that intentionally reporting data that are not the actual values obtained, intentionally reporting dates and/or times or data analyses that are not the actual dates and/or times of analyses, intentionally representing another individuals work as their own; or any other action that may affect the integrity of the data reported by the laboratory; will be the cause for dismissal.

1.9 ACCREDITATIONS

Through applications, pre-qualification, performance testing, and external auditing programs; the laboratory has been granted certification by different agencies, organizations, and states. The Laboratory maintains proficiency as required by the clients and regulatory certifying agency. The Quality Assurance Manager maintains credentials and lists of certifying agencies. The list of certifications maintained by the Oak Ridge Laboratory includes:

State of Tennessee, Department of Health ï Laboratory Division
State of California, Department of Public Health ï ELAP Branch
State of South Carolina, Dept of Health & Environmental Control, Environmental Lab Certification Program

State of Utah, Department of Health Bureau of Laboratory Improvement
State of New Jersey, Department of Environmental Protection, Office of Quality Assurance
State of New York, Department of Health, Environmental Lab Approval Program
State of North Dakota, Dept. of Health Environ. Lab. Certification Program - Chemistry Division
State of Nevada, Dept. of Conservation Bureau of water Quality Environmental Lab Services
State of Louisiana, Department of Environmental Quality
State of Texas, Texas Commission of Environmental Quality
State of Alabama, Department of Environmental Management
Commonwealth of Virginia, Dept. of General Services Division of Consolidated Lab Services
State of Washington, Department of Ecology**Perry Johnson Laboratory Accreditation, Inc.**
Department of Energy (DOE)
Department of Defense (DoD)

2.0 ORGANIZATION AND RESPONSIBILITY

2.1 ORGANIZATIONAL STRUCTURE

The Laboratory Manager has overall responsibility for this Quality Assurance Program (hereafter referred to as the Program). In this capacity, he has delegated the responsibility for formulation, implementation, and execution of the Program to the Laboratory Q.A. Manager.

Current organizational charts, identifying key individuals and the structure of the laboratory, are included in the "Statement of Qualifications." Additional organizational structure, functional responsibilities, levels of authority, and lines of communication for management, direction, and execution of the Program are documented below.

2.2 RESPONSIBILITY

Laboratory Management will periodically assess the integrated quality assurance program, its performance, and its effectiveness. Problems that hinder the organization from achieving its objectives will be identified and corrected.

Management will provide training and qualification to ensure quality products and services. Every employee is responsible for supporting the QA program policies, procedures, and guidance with each employee being responsible for their work. Professional qualifications and experience of all individuals and positions are maintained. Position descriptions and resumes are kept on file in the QA office. The specific duties of selected personnel are described below. Other job descriptions are located within an employeeꞌs training file in the QA office.

2.2.1 Laboratory Manager

The Laboratory Manager, under the authority of the President of Eberline Analytical Corporation, is responsible for the overall laboratory productivity and optimization of the efforts of the analytical staff and those who directly support the analytical effort. Staff interacts with the Lab Manager throughout the day. The Laboratory Manager is responsible for the implementation of regulatory standards, and national program requirements (NELAP, TNI, DOE, and DoD). The Laboratory Manager is responsible for the all safety aspects of the laboratory operations.

The duties of the Laboratory Manager include the following.

- Overall direction and general administration.
- Daily operation of the laboratory.
- Review of analytical procedures and practices.
- Recruitment, hiring, assignment, evaluation and termination of personnel.
- Training and professional development of staff.
- Review of proposals, bids, pricing and quotations.
- Perform an annual assessment of the laboratory operation.

2.2.2 Quality Assurance Manager

The Quality Assurance Manager operates independently from line management while reporting to the Laboratory Manager. The QA Manager has sufficient authority and organizational freedom to identify quality problems, to initiate, recommend or provide solutions; to verify implementation of solutions, and if necessary, to stop work until the problem is resolved. The QA Manager has independence from cost scheduling, and production considerations. In his capacity, he has the authority to control processing, delivery, installation, or use of items or services until proper disposition of an identified non-conformance, deficiency, or condition adverse to quality. The QA

Manager has a direct line of communication to the President of Eberline Analytical Corporation for matters of quality.

The duties and responsibilities of the QA Manager are as follows.

- Develop QA procedures, instructions and plans.
- Maintain surveillance over all applications of the QA Program; make recommendations for resolution of problems, or further evaluation by management.
- Monitor external audits, write responses, and ensure corrective actions.
- Issue non-conformances and formal corrective action(s).
- Issue stop-work orders for work that is not in compliance with requirements.
- Direct, and maintain records of analytical performance evaluation programs to ensure full and prompt participation and evaluation of results and derivation of all benefits relating there from.
- Direct, and maintain records of laboratory certification programs.
- Authorized to sign and designate other personnel to sign client related Certificates of conformance and/or non-conformance.
- Ensures compliance with Regulatory Standards and National Program requirements (e.g. NELAP, TNI, DOE, DoD, . . .)

2.2.3 Health and Safety Manager

The Health and Safety Manager reports directly to the Laboratory Manager and oversees the daily implementation of the laboratory's health and safety program. The program includes an integrated chemical hygiene plan, safety orientation and training, radiation safety plans and training, sample disposal and shipment, and safety checks and audits.

- The duties and responsibilities of the Health and Safety Manager are as follows.
- Administer chemical hygiene, safety, fire extinguisher, etc. training.
- Management of sample disposal in conformance with the waste disposal policy.
- Packaging and shipment of samples, or designation thereof, following DOT regulations.
- Maintain Material Safety Data Sheet (MSDS) documentation.
- Direct spill response.
- Direct safety checks and audits.
- Ensures compliance with regulatory standards and national program requirements (NELAP, TNI, DoD, DOE, . . .)

2.2.4 Technical Director

The Technical Director reports directly to the Laboratory Manager and provides technical direction or advice for the laboratory operations and/or special programs, projects, or activities.

- The duties and responsibilities of the Technical Director are as follows.
- Perform technical analysis for specific projects.
- Make recommendations for research and development.
- Write technical manuals.
- Design systems, procedures, and documentation as necessary.
- Assist chemistry supervisors and technicians in technical interpretation of program requirements.
- Consult with clients, make recommendations regarding analytical schemes.

2.2.5 Data Review Department Staff

The Data Review Department has been structured to handle the specific project requirements of our clients. The Department is responsible for producing quality control (QC) reports, for ensuring proper assembly of data packages and production of electronic data deliverables (EDDs) that meet the requests of the clients. Data Review personnel, in concert with the QA Manager, will assess the requirements of the various programs and client specific requirements, then interact with the appropriate laboratory personnel to ensure compliance with the client's statement of work. These efforts improve the accuracy and efficiency with which QC reports and data packages are prepared and forwarded to the client. Data deliverables are those items associated with the analyses of samples that are provided to the client.

Data Review staff responsibilities include the following.

- Assuring that analytical data have been correctly entered in the final report.
- Assuring that data are not released without reviews.
- Assuring that all data are released to the correct contact person.
- Producing QC reports.
- Assembling Data Packages.
- Ensuring that submitted EDD are complete, verified and in appropriate format.

2.3 ASSESSMENT

2.3.1 The Laboratory Manager will perform routine and continuous assessment of the management system to identify, correct, and prevent management problems that hinder achievement of the organization's objective. The assessment will focus on broad categories of management issues to determine the effectiveness of the integrated management system.

2.3.2 Laboratory Manager's assessments will not be conducted to verify conformance to regulations, product standards, or established procedures, but will evaluate customer and employee perceptions relative to the following key issues.

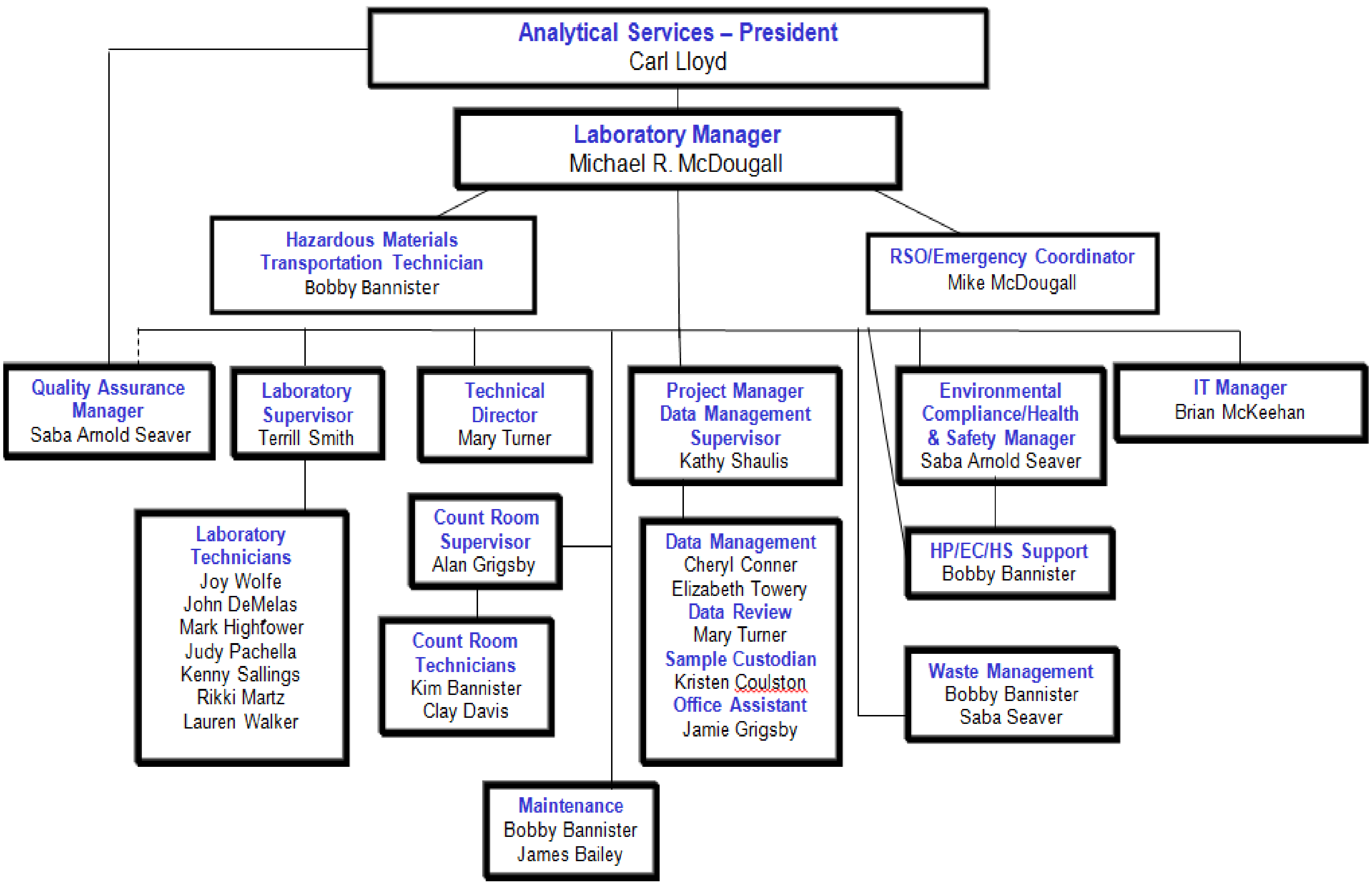
- Mission and strategic objectives of the organization.
- Employees' role in the organization.
- Customers' expectations and degree to which expectations are being met.
- Opportunities for improving quality and cost effectiveness.
- Recognizing and enhancing human resource capabilities.

2.3.3 Results of the Laboratory Manager's management assessment and recommendations will be documented annually. Decisions and related actions resulting from the recommendations will be properly followed up and evaluated for their effectiveness. Moreover, the opportunity for customer feedback is afforded by means of an on-line customer feedback/satisfaction survey on the laboratory website.

2.4 ORGANIZATION CHARTS

2.4.1 The Oak Ridge Laboratory Organization is illustrated in Figure 2.1

Figure 2.1
Oak Ridge, TN Laboratory Organization



3.0 QUALITY ASSURANCE OBJECTIVES

3.1 OBJECTIVES

The Oak Ridge Laboratory Q.A. Program is organized to meet the following objectives.

3.1.1 To ensure performance of those actions that provide confidence that quality is achieved.

3.1.2 To provide an effective control for the verification of characteristics of all systems, services, and processes that produce data of the required quality.

3.1.3 To ensure that systems, services, processes, and deliverables meet the rigid quality and reliability standards of the Oak Ridge Laboratory. Also, to ensure that individual client criteria pursuant to these standards are met.

3.1.4 To provide a continuing monitoring service for review of operating procedures, and for overall effectiveness and evaluation of the Q.A. Program. Also, to provide observations and recommendations for improvement in all areas of laboratory operations where quality may be affected.

3.1.5 To ensure the program provides valid records of the control measures applied to all factors bearing on the result of investigations.

3.1.6 To ensure the assessment of results provides feedback to improve the process.

3.1.7 To foster a culture of commitment to achieve a rising standard of quality that demands that the methods utilized to achieve the quality systems, services, processes, and deliverables be continuously monitored and improved.

3.2 QUALITY IMPROVEMENT

Operational processes will be reviewed continually by management and employees to detect and prevent problems and to ensure quality improvement. Any item or process that does not meet established requirements will be identified, controlled, and corrected. The cause of problems will be identified with corrections made to prevent recurrence. Item reliability, process implementation, and quality-related information will be reviewed and the data analyzed to identify items and processes needing improvement.

3.3 RESPONSIBILITIES

Employees are an integral part of the organization and are responsible to be aware of their work environment, to review operational processes and materials utilized, to identify any problems, and to make suggestions and recommendations for improvement. Employees are empowered to make and/or recommend corrections to improve operations and to prevent recurrence of the problems. Employees are also empowered, through their supervisor, to stop work where detrimental ethical, contractual, quality, safety, or health conditions exist. Management will immediately be made aware of any situations requiring work stoppage.

All employees are responsible for supporting the Program in principle and in detail and shall retain responsibility for the quality of their work.

Management is responsible to be actively involved in the quality improvement process to ensure proper focus is maintained and for resolution of difficult issues. Management will maintain a ño faultò attitude to encourage employees to identify problems that compromise safety and reliability. Management will consider all recommendations for quality improvement and will recognize employee contributions.

3.4 CORRECTIONS

Items and processes that do not meet established requirements must be identified, documented, analyzed, and resolved. Corrective actions will be implemented and followed up to ensure effectiveness.

No laboratory analytical data will be revised or corrected after reporting to clients without full documentation of the process. The documentation must show: a) what necessitated the change; b) details of the change in terms of re-run records or recalculation; c) approval process for the change; d) formal client notification.

4.0 PERSONNEL QUALIFICATION AND TRAINING

4.1 QUALIFIED PERSONNEL

4.1.1 The Oak Ridge Laboratory personnel who perform activities that affect quality will have education, experience and training to ensure that suitable proficiency is achieved and maintained. A job description, identifying position qualification and duty requirements, will be included in each individual's training records.

4.1.2 All personnel will have training outlining their ethical and legal responsibilities, including the potential punishment and penalties for improper, unethical, or illegal actions.

4.1.3 Personnel performing technical functions or processes will have known and documented related work experience and minimum qualifications of education.

4.2 RESPONSIBILITY

4.2.1 Supervisors are responsible for initial evaluation of capabilities and qualifications of assigned personnel and will assign those personnel to perform functions based on the individual's qualifications and abilities.

4.2.2 Supervisors and managers are responsible for the day-to-day monitoring of assigned personnel for evidence of unethical, improper, or illegal activities.

4.2.3 Appropriate training is the responsibility of the supervisors with support from management. Training will address specific needs and will vary according to each job's requirements and previous experience of the employee, and will ensure:

4.2.3.1 Understanding of the fundamentals of the work and its context,

4.2.3.2 Understanding of the processes and tools being used, the extent and sources of variability in those processes and tools, and the degree to which control over the variability is maintained,

4.2.3.3 Emphasis on correct performance of the work, understanding why quality requirements exist, and potential consequences of improper work, and

4.2.3.4 Emphasis on "doing it right the first time.ò A particular emphasis is placed on employee safety.

4.2.4 Management will provide ALL employees the resources, tools, equipment, scheduling, and structured training to ensure personnel can perform their duties effectively. New employees will receive detailed information concerning the general corporate policies and the specific laboratory safety practices, and security policies. Training shall be conducted on an individual basis to achieve and maintain suitable proficiencies. The training will include, but will not be limited to:

- Ethical and Legal responsibilities
- Health and Safety
- Radiation Protection
- Waste Management
- Quality Assurance
- Laboratory Procedures
- LIMS Operation

4.2.5 Access to all laboratory documents and procedures will be available at all times to all employees who will be expected to familiarize themselves with these documents.

4.2.6 Milestone achievements or unique training will be noted by the supervisors via entry in the training records. Available certificates of training, education, or awards will also be maintained with the individual's training records.

4.2.7 Supervisors will monitor individual work habits to ensure proficiency is maintained, to note progressive improvement, and to identify any needed supportive training. Additional training requirements will be developed by the individual's supervisor.

4.2.8 As needed, employees will be informed of the requirements of special clients/programs necessary to achieve their duties and responsibilities. Familiarization will be made a matter of record.

4.2.9 All personnel training records will be maintained in the QA office. The details for maintenance of training requirements and records are outlined in the Oak Ridge Laboratory Management Procedure, MP-042 "Personnel Training."

5.0 INSTRUCTIONS AND PROCEDURES

5.1 POLICY

The Oak Ridge Laboratory policy uses written and approved procedures for routine activities and for analytical and operational processes. Applicable Laboratory procedures are available to all personnel. The most current revision of the appropriate procedure will be maintained and documented on the laboratory computer server. Departures from routine procedures due to non-standard situations or specific requests from clients will be approved by management and fully documented.

In addition to analytical procedures (AP) the laboratory maintains Management Procedures (MP) that describe the policy and approach for performing quality functions. Separate procedures for Health and Safety, Radiation Protection and Waste Management, are also maintained.

5.1.1 ANALYTICAL PROCEDURES

Analytical procedures are descriptions of particular protocols for testing or operations. Analytical procedures will be developed based on published reference procedures for each test or process, and authorized for use by the Laboratory Manager.

5.1.2 Qualification requirements for personnel performing operations and criteria used to determine the proficiency of the operator will be documented.

5.1.3 Each technical procedure will include a list of Personal Protective Equipment (PPE) required for the operation being performed. Training for the identification, operation, use, limitations, and disposal of the PPE will be conducted.

5.1.4 Each technical procedure will identify any chemicals/reagents required for completion of the operation. Material Safety Data Sheets (MSDSs) for those chemicals/reagents will be readily available, and training applicable to the MSDSs will be conducted.

5.1.5 Training will be conducted to the procedures used for processing wastes generated within the appropriate chemistry laboratory.

5.2 PROCEDURE MANUALS

Procedure manuals consist of the individual analytical procedures for a laboratory area or for an operation combined into one document. The procedures within the manual define all parameters of the operations being performed to include required accuracy and completeness of specific measurement parameters involved. Procedures will be incorporated into procedure manuals. Signature on the Authorization and Approval page applies to all procedures in the manual.

5.3 FORMAT AND DISTRIBUTION

5.3.1 Procedures will comply with the format prescribed in the laboratory management procedure (MP-021, Preparation of Technical and Project QA Documents) and will be approved by the QA Manager and the Laboratory Manager.

5.3.2 Employee access to the most current revision of procedures and manuals will be through the Laboratory computer server. Any distribution of controlled copies of any Laboratory procedure will be in accordance with the laboratory's document control protocol.

5.3.3 The Laboratory Manager is responsible for the maintenance and security of the original electronic version of all laboratory procedures and manuals and for ensuring that the most current revision of the procedures and manuals are promptly posted and accessible to all employees.

5.4 REVIEW

Laboratory technical procedure, manuals and Quality Assurance Plan will be reviewed annually and whenever program or procedural changes occur with updates as appropriate. Such reviews will be documented. All effected laboratory personnel and document holders will be made aware of any changes. Training of laboratory personnel on new changes will be conducted as necessary.

5.5 REVISION

5.5.1 The appropriate supervisor, or designated representative, is responsible for revisions or changes to the applicable procedure manuals.

5.5.2 Revisions are reviewed and approved by the organization(s) and personnel responsible for the original document. When possible, revisions or changes will be accomplished on a page replacement basis.

5.5.3 The Q.A. Manager will be advised of any changes in procedures required to satisfy specifications of the client.

5.5.4 The final revision shall be reviewed, approved, and authorized by the laboratory manager and QA manager. The electronic copy is placed on the laboratory server for access.

5.5.5 The Q.A. Manager will be responsible for the electronic retention of past revised and superseded procedures. The Q.A. Manager will also be responsible for maintaining the server location where current revisions are stored for employee reference.

6.0 PROCUREMENT DOCUMENT CONTROL

6.1 PURCHASING

Procurement of material, components, supplies, reagents, equipment, and services necessary to carry on the business interests of the Oak Ridge Laboratory is initiated by purchase requisition and controlled by the use of an authorized purchase order number. To the extent necessary, purchase orders will require suppliers to have a Q.A. program consistent with the requirements of this document. Detailed information on procurement is outlined in the laboratory's Purchasing Procedure.

6.2 PURCHASE REQUISITION REVIEW

Purchase requisitions or change orders are reviewed by purchasing department personnel to ensure conformance to the procurement requirements. As applicable, quality related requisitions are reviewed by Q.A. personnel prior to being processed. Change orders undergo the same review process.

6.3 CERTIFICATION/CERTIFICATE OF CONFORMANCE

All materials and processes requiring certification and certificates of conformance are identified on the face of the purchase requisition. Adequate information is provided to ensure supplier compliance to the required specifications. The Q.A. Manager is responsible for the retention, filing, and recall of material certification or certificates of conformance.

6.4 SUBCONTRACTS

When subcontracting analytical work, Oak Ridge Laboratory Management will ensure that the subcontractor can meet all the technical specification, maintain the appropriate certification (NELAP, DOE, DoD, State, . .) and that the prospective subcontractor has a QA program consistent with the requirements of this document. The Oak Ridge Management will secure the client approval for subcontracting their analytical work prior to commencement of the subcontract. The Q.A. Manager is responsible for evaluation and acceptance of the subcontractor's Q.A. program.

6.5 VENDORS

6.5.1 For procurement of quality-related items or services, the Q.A. Manager is responsible for vendor evaluation and approval. Analytical service vendor evaluation and qualification will be through accreditation as a secondary standard calibration laboratory (NVLAP, NIST); an audit by Oak Ridge Laboratory personnel or an acceptable audit agency; or facility inspection, test reports, or receipt inspections, when the quality of the materials or service can be verified by these methods. Documentary evidence that products and services conform to procurement requirements will be provided and retained. A list of approved vendors will be maintained by the Procurement Office.

6.5.2 The effectiveness of the control of quality by contractors and subcontractors will be assessed at intervals consistent with the importance, complexity, and quantity of the product or services.

6.5.3 The purchasing department is responsible for maintaining a record of quality related materials received from vendors including any reports for non-conforming material.

6.6 QUALITY RELATED SERVICES

Q.A. personnel will review the purchase requisitions for quality related services. Those services that are determined to be quality related will include, as applicable, a statement, or wording, in the body of the purchase order or by attachment identifying the applicable requirement.

7.0 MATERIAL RECEIPT AND CONTROL

7.1 POLICY

Only material components, supplies, reagents or standards with acceptable quality characteristics and from qualified vendors will be allowed into the laboratory.

7.2 RESPONSIBILITY

Receipt and initial verification of all materials and equipment received by the Oak Ridge Laboratory, either purchased or contract (client) supplied, is the responsibility of the receiving or designated individual. Technical verification for materials and equipment will be performed by the requisitioner or Q.A. Manager, whichever is applicable. Quality related purchase order items will be receipt inspected by Q.A. personnel.

7.3 MATERIAL CONTROL

Purchased material is controlled by the Laboratory Supervisor or designated individual.

7.3.1 The receiving and stock control clerk, or designated individual, is responsible for the expedient and correct routing of all initially accepted received materials to stock, or to the requisitioner.

7.3.2 Purchasing department personnel are responsible for maintaining a record of materials received from vendors, including Rejected Material Report or equivalent form, for any non-conforming material.

7.4 NON-CONFORMING MATERIAL

When received material, affecting quality, has been determined to be non-conforming, the requisitioner will work with the purchasing agent and will be responsible for proper processing.

7.5 RECORDS

Records of receipt of services and supplies that affect the quality of laboratory operation will be identified with date of receipt, expiration date, source, lot or serial identifier, and calibration or certification records as appropriate.

8.0 MATERIAL STORAGE AND CONTROL

8.1 POLICY

All materials and supplies in storage will have the necessary protection to preclude deterioration, corrosion, or damage during storage life and will carry identification sufficiently clear to ensure that only those materials specified by process instructions will be withdrawn from material storage and issued for processing.

Only analytical grade chemicals and reagents, bearing such grade identification will be utilized by the Laboratory. Each container will be assigned a unique identification number upon receipt. The date of receipt will be posted on each container. The use and the retention (shelf life) of such chemical will be monitored by the Laboratory Supervisor.

All standards used by the Laboratory must be NIST certified. Each standard must be accompanied with a certificate showing the name, composition, concentration, reference number and NIST Certification. The use and distribution of these standards will be monitored by the LIMS. The certificate and certification documents of standards will be controlled by the QA department.

8.2 RESPONSIBILITY

Only authorized personnel will have access to, and the responsibility for, control and issue of materials or supplies. Materials and supplies will be stored to allow for ready identification. Care will be taken to preclude mixing of rejected material and supplies with those that are qualified for issue.

9.0 CONTROL OF PROCESS

9.1 STANDARD PRACTICES

Standard practices applicable to services provided by the Oak Ridge Laboratory are contained in documented procedures and this Q.A. Program Manual. Every effort is made to implement and fulfill the requirements of Federal and local laws, rules, guidance(s), and directives as may be applicable to the operational practices within the Oak Ridge Laboratory. These may include but are not limited to:

9.1.1 Federal and State rules and regulations.

9.1.2 Consensus standards related to the services performed (e.g., American National Standards Institute).

9.1.3 Regulatory Guides published by the Nuclear Regulatory Commission, Department of Energy, the Environmental Protection Agency, and the Department of Defense.

9.1.4 Specific contractual agreements with clients.

9.1.5 Where conflicts may occur among any of the above items, the client will be notified and requested to specify the practice to be followed.

9.2 DOCUMENTED PROCEDURES

Routine analytical operating procedures are documented. Each laboratory procedure includes quality control criteria that are applicable to that process. The laboratory management will develop, promulgate, and implement procedures that document the operations performed in the laboratory. Additionally, the following general procedures or documents, as applicable, will be developed:

9.2.1 Quality Assurance Procedures

9.2.2 Radiation Safety Manual and Procedures

9.2.3 Sample Control Procedures

9.2.4 Purchasing Policies and Procedures

9.2.5 Data Review Procedures

9.2.6 Environmental Compliance Procedures

9.2.7 Safety Procedures

9.2.8 Chemical Hygiene Plan

9.2.9 Hazard Communications Program

9.2.10 LIMS Procedures

9.2.11 Management Procedures

9.2.12 Analytical Procedures

9.3 RESPONSIBILITY

The Laboratory Manager, or designated representative, determines which instructions or procedures require quantitative or qualitative acceptance criteria and specify the appropriate criteria on special contracts or projects.

9.4 WORK POLICY

All work to be performed by the Oak Ridge Laboratory on client samples is authorized by the client and controlled through a Laboratory Information Management System (LIMS) work order document which incorporates the client's requirements. (Or by some other document deemed necessary by the Laboratory Manager or Project Manager as directed by the customer)

9.4.1 The work order specifies those analyses necessary to assure compliance with contractual obligations.

9.4.2 The Project Manager or designated personnel ï under the authority of the Laboratory Manager, are responsible for notifying the Q.A. Manager and performing laboratory departments, through the appropriate supervisor, of all contract requirements including reporting format and quality control criteria. This may be done by reference to other documents (e.g., Purchase Order, statement of work, technical specifications, etc.) that delineates the contract requirements.

9.4.3 The Project Manager or designee ï under the authority of the Laboratory Manager-, will ensure planning, scheduling, and resources are considered when contracting for or accepting work.

9.4.4 When subcontracting analytical services, the Project Manager or designated individual under the authority of the Laboratory manager-, will assure that:

- The client is notified in writing of the intention to subcontract any portion of the testing to another party.
- If the work is covered under NELAP, the work will be placed with a laboratory accredited under NELAP for the tests to be performed.
- Records, demonstrating that the above requirements have been met, are retained in the project folder.

10.0 PREVENTIVE MAINTENANCE

10.1 POLICY

Preventive maintenance is performed as required on instrumentation and equipment to prevent down time and to ensure reliable performance. The laboratories maintain instrument redundancy that precludes the requirement for a repair and maintenance capability for instrumentation. Maintenance and/or repair of equipment are performed by the equipment manufacturer or authorized representative under contract or purchase order.

10.2 MAINTENANCE

Preventive maintenance procedures will be developed for use where instructions are not provided in the manufacturer supplied operator's manual. As applicable, each department will maintain a major equipment and measurement standards list. A record of instrument maintenance, calibration, and repair, if applicable, will also be maintained. The supervisors and operating personnel are responsible for complying with the department maintenance schedule.

10.3 SPARE PARTS

Supervisors will ensure that an adequate inventory of spare parts and consumables is requisitioned and maintained for instrumentation in their area in order to prevent down time or compromise operating conditions.

11.0 CONTROL OF MEASUREMENT AND TEST EQUIPMENT

11.1 MEASUREMENT AND TEST EQUIPMENT CALIBRATION POLICY

This section establishes the controls and calibration requirements for all analytical and nuclear measurement equipment. An equipment list will be maintained indicating calibration status.

11.1.1 All equipment whose operation and function directly affect the quality of service will be inspected/calibrated at established intervals. As applicable, equipment will be suitably identified to reflect calibration status. If an instrument is determined to be out-of-tolerance, it will be segregated, or otherwise clearly identified as inoperable. Records of each calibration will be kept in appropriate logbooks or files. Instruments whose calibrations are performed during method operations are calibrated and controlled in accordance with the method requirements. Run logs will be maintained for this category of instrumentation.

11.1.2 The equipment used to determine the quality characteristics and accuracy of instruments will be checked and verified either internally (dependent upon capability), or by qualified calibration services.

11.1.3 Frequency of inspection/calibration will be based on use of the equipment or instrument, environmental conditions in which it is used, its inherent stability, manufacturer's recommendation, and the wear or deterioration resulting from its use.

11.1.4 Certified standards are used for all primary calibrations. National Institute of Standards and Technology (NIST) or NIST traceable, Environmental Protection Agency (EPA), New Brunswick Laboratory (NBL), or Department of Energy (DOE) standards are used, when available, for the primary calibrations or verification of primary calibrations.

11.1.5 All preparations of standard solutions are recorded in a standards preparation logbook or file. Identities of standards are such that a secondary standard or dilution can be traced, through subsequent actions, back to the initial certification. Records of these reference standards are organized in a secure location in the QA office.

11.1.6 Quality control check standards are used to record instrument sensitivity and linearity and to verify proper response. Methods and calibration entries are dated, initialed, and documented by the analyst.

11.1.7 Measuring and test equipment are tagged as to calibration or operating status for periodic processes performed on a scheduled interval of greater than one month. For processes performed more frequently, separate documentation will be available for verification of operational status. Instruments that are too small to be tagged or are subject to a wide variety of calibrations shall have separate documentation of status available.

11.2 RESPONSIBILITY

Testing and/or calibration of equipment and instruments will be performed under the direction of the supervisor, the department manager, or the operations manager and performed under suitable environmental conditions.

11.3 PROCEDURES

All tests and calibrations will be performed in accordance with written procedures that contain provisions for ensuring that all prerequisites for the given test have been met, including appropriate equipment to be used.

11.4 CERTIFICATION AND CERTIFICATES OF CALIBRATION

11.4.1 To the extent possible, calibration will be traceable to NIST. Records of traceability will be maintained along with records of routine calibrations of each instrument or measurement system. Where no NIST traceability exists, the basis used for calibration will be documented.

11.4.2 Equipment records will be maintained to indicate past and current status, and to provide reproducibility and traceability of results.

11.5 RADIOACTIVE SOURCE CALIBRATION

Radioactive sources used as calibration standards will be periodically calibrated and controlled. Current calibration certificates will be kept on file.

11.6 CALIBRATION RECORDS

Supervisors will ensure that calibration data for instruments and radioactive sources is recorded in the instrument logbook, on data work sheets, on computer files and/or control charts. When required, new calibration charts will be prepared when there is measurable change in calibration effect on instruments that have been calibrated. If an instrument is determined to be out of tolerance, it will be segregated or otherwise clearly tagged as inoperable and not used until repaired.

11.7 REPORTS GENERATED FROM USE OF A DEFICIENT INSTRUMENT

If a major deficiency in an instrument or device is detected during periodic calibration procedures, the technician will immediately notify the supervisor, the operations manager, and the Q.A. Manager. A conference will immediately be scheduled to investigate and decide what corrective action is to be taken on past data and reports resulting from the use of the deficient instrument or device. A record of corrective actions will be maintained.

11.8 PERFORMANCE CHECKS OF RADIATION SCREENING INSTRUMENTS

Performance checks will be made to ensure the continuing capability of radiation screening instruments. Procedures will include efficiency checks and background determinations. The procedure and frequency of each check is optimized for each detector system to provide assurance of the detector's performance. Documentation of the checks and the results are kept for all operations.

12.0 DATA REDUCTION, VERIFICATION, AND REPORTING

12.1 USE OF COMPUTER HARDWARE AND SOFTWARE

Computer programs used in the production or support of client data are either purchased, or developed using approved development methodology. Such programs are independently validated, verified, and documented. Changes are controlled to assess the potential impact of the change on the performance of the program.

12.2 DATA REDUCTION AND VERIFICATION

Sample receipt and distribution through the laboratory is documented by the sample receiving technician. Sample handling, subsampling, and preparation for counting measurement are documented by the laboratory technicians.

12.2.1 The successful completion of an analysis is monitored by the Counting Room staff. The Laboratory Manager, or designated individual, performs the final review and approves the data.

12.2.2 Calculation methods, transcriptions, and data flow, plus times and locations of the various tiers of review are detailed in the specific procedure.

12.3 REPORTING

The Project Manager or designated individual is responsible for providing the client with the required analytical results. Reports to clients will be reviewed for accuracy and completeness and, where required, analytical methods and minimum/method detection limits (MDL) will be reported. Laboratory reports of analyses will be signed by an authorized individual who, along with the person who signed the data sheets, can attest to the fact that the data was generated in accordance with established procedures.

13.0 DOCUMENT CONTROL

13.1 POLICY

The primary formal communication methods within the Oak Ridge Laboratory departments are documents that inform or direct activities affecting purchasing, sample analyses and reporting, instrument calibration and/or testing, radiation controls, proper handling of wastes, radiation safety, and Health and Safety. These documents are controlled by the Q.A. Program Manual, Operating Procedure Manuals, other documented procedures, or by interoffice memoranda. Drawings and specifications are not controlled as separate documents but are included in controlled procedures where applicable. The QA Office controls logbooks used to document the analysis of samples (see MP-023, Documentation of Analytical Laboratory Notebooks).

13.2 RESPONSIBILITY

13.2.1 The Q.A. Manager is primarily responsible for maintaining files of all controlled documents and will:

- Review the Quality Assurance Program Manual and provide recommendations for updating.
- Ensure that all holders of controlled documents receive updates to the documents.
- Maintain files of controlled document distribution indicating document title, number, revision number, assigned date, and the name of the individual to whom the document is assigned.
- Forward revisions of controlled documents to assigned individuals. An acknowledgment form will accompany each document revision for verification of receipt and to provide disposition instructions for the superseded pages
- Maintain a Master List of current procedures which includes procedure number, procedure title, current revision number, and date on which the current revision became effective. The list will be continually updated to reflect all new revisions or new procedures issued. An electronic copy of this list shall be available for employee reference at all times.

13.2.2 Uncontrolled copies of controlled documents will be distributed only if marked "Uncontrolled."

13.2.3 Superseded and/or obsolete documents are isolated from use or destroyed. Upon training to new revisions, employees sign to verify the destruction of all uncontrolled copies of obsolete revisions.

13.2.4 Each employee is responsible for requesting revisions or changes to operating procedures for their area of responsibility.

13.2.5 The Q.A. Manager will be advised of any changes in procedures required to satisfy client specific requirements.

13.2.6 Client information and records such as contract requirements, project descriptions, analytical data and results submitted to the client; and all laboratory records associated with such submittal will be maintained by the laboratory for a minimum of 5 (Five) years. Clients will be contacted and queried for disposition instructions for their related documentation.

13.2.7 If or when the laboratory may transfer ownership, is decommissioned, or goes out of business, ALL clients will be notified and asked to provide specific direction regarding the transfer or disposition of documents and records related to their project(s).

14.0 INTERNAL QUALITY CONTROL

14.1 LABORATORY ANALYTICAL SERVICES

Precautions are taken in the chemistry laboratories to avoid cross-contamination of samples and to ensure the reporting of accurate results. Quality control samples are analyzed along with routine samples to indicate when results may be in error due to improper operation or calibration of equipment, inadequate training of personnel, a deficiency in the procedure, or cross-contamination from other samples.

14.1.1 Laboratory Precision - Laboratory management personnel are responsible to ensure that analytical results are reproduced internally within acceptable limits.

14.1.2 Precision and Accuracy - Replicate standards and/or samples are used to estimate the precision of each analytical test procedure for a known matrix. Data control limits are established to satisfy the requirements of specific measurements based on prior knowledge of the measurement system and method validation studies. Certified standards and/or spiked samples are used to estimate chemical recovery and accuracy for these procedures for known matrices.

14.1.3 Calibration and Performance Checks of Nuclear Measurement Systems - Reference standards are used for calibrating nuclear measurement systems. In addition to calibration of all instrumentation, routine monitoring is performed to ensure the continuing integrity of the instrument performance. The monitoring parameters performed include efficiency checks, background determinations, and energy calibrations. The procedure and frequency of each check is optimized for each detector system to provide assurance of the detector's performance. Documentation of the checks and the results are kept for all systems. The supervisor is responsible for these calibration and performance checks.

14.1.4 Duplicate Analysis - Duplicate aliquots of randomly selected samples will be processed on a routine basis. The analyst will always process samples in accordance within approved operating procedures. The evaluation of the duplicate analysis will be based on examination of the difference between the duplicates. A statistical analysis of the data may be performed when a cursory evaluation indicates problems with the results. If the two results agree within the three standard deviation limits, a more detailed evaluation will generally not be necessary. Results of duplicate analyses will be included in the monthly Q.C./Q.A. report.

14.1.5 Detection and Elimination of Bias - Where possible, calibration will be with standards that are traceable to NIST. However, traceability to NIST is not always possible and reliance on other suppliers may be necessary (e.g., International Atomic Energy Agency, U.S. Department of Energy, U.S. Environmental Protection Agency, or commercial supplier such as Analytics, Amersham Biosciences, AEA Technology, etc.). Standards in the appropriate geometry or form will be used to determine efficiency of instruments on a periodic basis. In the calibration process, the ideal standard will be a known quantity of the radionuclide to be measured, prepared in exactly the same geometry as the samples and counted under the same conditions. In this way, factors such as self-absorption, backscatter, sample geometry, and detector efficiency will be accounted for empirically.

14.1.6 Spiked Samples - A known quantity of calibrated radioactive standard solution will be added to an aliquot of the sample or to a "blank" sample for replicate analysis. When the entire analytical system is operating properly, the laboratory record will demonstrate the accuracy and precision of the data. Divergent data from the spiked sample will point out problem areas. If the data is consistently higher or lower than the known value, bias in the analytical procedure is indicated. This may require a search for personnel errors, re-standardization of carriers or tracers, and/or recalibration of counting equipment. .

14.1.7 Background Determination - The type of equipment and environmental factors contribute to variation in the counting rate of instrument background. The background of each system instrument will be determined and recorded with sufficient frequency to provide a firm statistical basis for that measurement and to ensure response to potential instrument problems or other artifacts such as controlled contamination.

14.1.8 These background determinations will include use of the items that most closely duplicate the analytical configuration in type, geometry, and with any associated fixtures. In some cases, true blanks are not available, but the closest practicable analog is used.

14.1.9 Some systems are sufficiently stable to require no change in backgrounds used for data reduction (e.g., uranium daughter gamma-rays found in gamma spectra due to adjacent building materials and earth). In this case, backgrounds will be compared to historical data to insure sufficient stability. Other systems experience enough variability to require computed backgrounds based upon running averages.

14.1.10 Background data will be recorded in the logbook or computer file for that specific instrument along with calibration data and instrument maintenance records.

14.1.11 Blanks - Blank samples are routinely analyzed to verify control of contamination and process. Results of processed blanks will be included in the monthly Q.C./Q.A. report.

14.1.12 Collaborative Testing - The Oak Ridge Laboratory participates in collaborative testing or inter-laboratory comparison programs. Natural or synthetic samples prepared to contain known concentrations of certain radionuclides are sent to participating laboratories by an independent referee group such as the DOE Radiological and Environmental Sciences Laboratory DOE, Idaho Falls, Idaho (MAPEP); by a NELAC approved provider such as the Environmental Resources Agency (ERA), Environmental Measurements Laboratory (EML), or by customer(s).

These programs enable Oak Ridge Laboratory personnel to document the precision and accuracy of radioactivity measurements, identify instrumental and procedural problems, and compare performance with other laboratories.

14.2 QUALITY CONTROL AND DATA REPORTS

14.2.1 Quality Control Reports

Quality control results will be summarized, and include with every sample/group of samples.

14.2.2 Data Reports

Routine performance requires documentation of all pertinent information with the basic documents dated and initialed or signed. Required documentation will be the initial work order, Chain-of-Custody (CoC), or document that records all pertinent information such as the identity of the sample and analyses to be performed. The data report will include technical analysis notes, logbooks, work sheets all raw data and other information used in performing the analysis. The report of analysis will be the final report of the data to the client and is issued in accordance with the laboratory's procedure for review and processing, as well as any client specific requirements.

14.3 DATA VERIFICATION

Routine performance requires inclusion of all pertinent information with basic documents dated and initialed or signed. The work order has recorded such information as the identity of the samples and analyses to be performed. All raw data and other information used in performing the analyses are documented.

14.3.1 Electronic Deliverables Verification - Project managers, or designated individuals, are responsible for ensuring that electronic deliverables are complete and accurate.

14.4 Sample Custody

Samples are assigned a unique laboratory identification number, marked on a label that is applied directly to the container and which identifies the work order and laboratory fraction. Sample control personnel are designated sample custodians for strict (legally defensible) CoC samples. Locked buildings, refrigerators, freezers, and cabinets are available for CoC samples. Sample custody forms or technician analysis notes are used for tracking all samples through the analytical process. Details for radiological survey of samples, sample security, sample disposal, etc. are outlined in approved Sample Control Procedures. Sample chemistry and nuclear counting requirements are assigned by the laboratory manager, or designated individuals.

15.0 AUDITS

15.1 POLICY

The Oak Ridge Laboratory has established a comprehensive system of planned and documented audits to verify compliance with all aspects of the Q.A. Program. An audit is defined as a documented activity performed in accordance with written procedures or checklists to verify, by examination and evaluation of objective evidence, that applicable elements of the Q.A. Program have been developed and effectively implemented in accordance with specific requirements. Audits will be performed by persons not having direct responsibility for those areas being audited.

15.1.1 Customer Access to the Oak Ridge Laboratory Facilities and Personnel - The client is frequently responsible for auditing the Oak Ridge Laboratoryꞌs performance relative to contractual requirements. The exact nature of this responsibility is relative to the nature of the regulatory or licensing requirements, the significance of the services, and the technical expertise available or inherent within the client's organization. The need for, and frequency of, client audits is dependent upon the above factors. A client may authorize an independent agency to perform an audit on its behalf. When possible, the facilities, equipment, and records (proprietary information excluded) of the Oak Ridge Laboratory will be made available for client inspection along with the necessary personnel to permit verification of quality characteristics.

15.1.2 The Q.A. Manager will coordinate and participate in audits conducted by the client or the client's representative.

15.1.3 Internal Audits - The Q.A. Manager will audit the laboratory operations to verify compliance with established procedures and requirements set forth in the Q.A. Program Manual. Use of a checklist will insure items in compliance are noted as well as any requirements for improvement.

15.1.4 External Audits - External audits of organizations providing services to the Analytical Services Group are scheduled at a frequency commensurate with the status and importance of the activity.

15.2 RESPONSIBILITY

Audits will be directed by the Q.A. Manager with assistance from designated personnel.

15.2.1 The Q.A. Manager will be responsible for an independent quality assurance audit of each department.

15.2.2 The Q.A. Manager will be responsible for assuring that audits are performed by knowledgeable professionals.

15.2.3 An independent qualified auditor will audit areas of responsibility assigned to the Q.A. Manager.

15.3 DOCUMENTATION

Audit results will be documented by the Q.A. Manager.

15.3.1 The Laboratory Manager shall be provided a copy of the audit report.

15.3.2 The QA Manager will determine if there are any corrective actions required and the individual responsible for implementing the corrective action

15.4 DEFICIENT AREAS

15.4.1 The responsible Manager will ensure correction of the identified deficiencies.

15.4.2 The Q.A. Manager will verify that action is taken to correct any deficiency and will take follow-up action to ensure that corrections have been completed.

15.4.3 The Q.A. Manager will ensure close out, with documentation, of the audit after corrective actions have been completed.

15.4.4 For uncorrected or unresolved deficiencies, after due diligence, the Q.A. Manager will petition the Laboratory Manager to bring to bear his authority for resolution of the deficiencies.

15.5 FREQUENCY OF AUDITS

The Q.A. Manager will ensure internal audits are conducted on an annual basis. Additional selective audits will be conducted when one or more of the following conditions exist:

15.5.1 When significant changes are made in functional areas of the Q.A. Program, including significant reorganization or procedure revisions.

15.5.2 When assessment of the Program's effectiveness is considered necessary.

16.0 QUALITY ASSURANCE AND INSPECTION RECORDS

16.1 POLICY

Records that provide objective evidence of the quality of work are generated and maintained. These records include controlled logbooks, customer instructions, sample analyses data sheets, and results of reviews, inspections, tests, audits, corrective actions, reports, and training records. Also included are related data such as personnel qualifications, procedures, and equipment records.

16.2 RESPONSIBILITY

The responsibility for initiation, completeness, and reliability of Q.A. records is vested in the appropriate supervisor, with periodic verification checks by the Q.A. Manager. All Oak Ridge Laboratory personnel performing processes or services associated with the work being performed will assist in the efforts.

16.3 RECORDS

16.3.1 Inspection and test records will, at a minimum, identify the inspector or data recorder, the type of observation, the results, the action taken in connection with any deficiencies noted, and the date of the inspection or test.

16.3.2 All required records will be legible and of a quality that can be copied. Records shall be completed using reproducible ink. Errors or incorrect entries will be lined through with a single line, dated, and initialed by the recorder.

16.3.3 Correspondence from clients may be made available for inspection at the discretion of client representatives and authorization from the originating organization.

16.3.4 Q.A. records will be identified and controlled by customer number and/or client identification as applicable.

16.4 STORAGE OF RECORDS

16.4.1 Quality assurance records will be firmly attached in binders, placed in folders or envelopes, and, if applicable, cross referenced by client identification and stored in a secure area.

16.4.2 Q.A. records will be properly stored and made available to the client upon request.

16.4.3 Records will be maintained in a secured and protective storage area.

16.4.4 Records will be identified and be retrievable.

16.4.5 CoC records are included with the sample set records.

16.4.6 Longer retention or duplication of records is available at the specific direction from the client.

16.4.7 Laboratory management will be responsible for governing access to, and controlling the records.

16.4.8 Analytical reports and source calibration data will be retained for a minimum of five years after results are reported to the client.

16.4.9 Procurement records will be retained for a minimum of five years or as required by the contract.

16.4.10 All records and analyses performed pertaining to (NELAC) accreditation will be kept for a minimum of 5 years and would be available for inspection by the accrediting authorities during this period even without prior notification to the laboratory.

17.0 CORRECTIVE ACTION

17.1 POLICY

The Oak Ridge Laboratory policy is to ensure continuous acceptable quality levels for services provided. Conditions adverse to quality will be identified and corrected as soon as practical.

17.2 CORRECTIONS

17.2.1 CORRECTIVE ACTION REPORT (CAR)

In the case of a significant condition adverse to quality, the cause of the condition shall be determined and corrective action taken to preclude recurrence. The identification, cause, and corrective action shall be documented and reported to appropriate levels of management. Follow-up action shall be taken to verify implementation of this corrective action and documented via a Corrective Action Follow-Up form. The Corrective Action Report (CAR) Form shall be used to document this condition. Typically, the Q.A. Manager will initiate investigation and corrective action by issuing a Corrective Action Report (CAR) in any of the following situations:

- When an audit reveals circumstances that will adversely affect quality (Audit Finding) as determined by the Q.A. Manager.
- When any results of an inter-comparison study are out of control, or for non-participation.
- When procedural or technical problems arise and the Q.A. Manager determines that they will significantly affect quality.

17.3 NON-CONFORMANCE REPORT (NCR)

A non-conformance is a deficiency in a characteristic, procedure, or documentation that renders the quality of an item unacceptable, however, is not considered a significant condition that would require an investigation by use of a CAR. In the laboratory, non-conformances can include physical defects, incorrect or inadequate documentation, and deviations from an established protocol, plan, or documented technical requirement. This condition is documented using a Non-Conformance Report (NCR) Form.

17.4 RESPONSIBILITY

All laboratory personnel are responsible to communicate any evidence of unacceptable quality performance to their supervisor, the responsible manager, and/or the Q.A. Manager.

17.4.1 The responsible manager will ensure investigation of a condition adverse to quality, determine assignable cause, and provide recommendation(s) for corrective action.

17.4.2 The responsible manager will ensure action is initiated to correct the assignable cause of the adverse condition and to determine and initiate the specific corrective action(s) necessary to preclude recurrence.

17.4.3 The Q.A. Manager will review CARs, NCRs, and routine Q.C. reports for evidence of unacceptable quality.

17.4.4 Copies of the completed CARs and NCRs will be kept on file by the Q.A. Manager.

17.5 CLIENT NOTIFICATION

The client will be notified when any Corrective Action is initiated due to evidence of unacceptable quality that is related to their contract.

18.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

18.1 POLICY

The Oak Ridge Laboratory policy is to keep management apprised of all quality assurance problems, actions taken to correct them, and any actions taken to prevent recurrence.

18.2 QUALITY ASSURANCE REPORTS

18.2.1 Quality Assurance Reports are prepared quarterly by the QA Manager and submitted to upper management. The reports shall include discussion of inter-comparison studies, status of corrective actions, and quarterly QA objectives.

18.2.2 The Q.A. Manager will report all general or system audit results, problems, corrective actions, and replies.

Document Revision History

Revision	Effective Date	Changes From Previous Revision
7	8/1/13	• Document Revision History table implemented • Added Emergency Coordinator to title designations of positions in Section 1.4.4 • Updated list of accreditations in section 1.9 to reflect all current certifications • Updated Laboratory Organization Chart • Removed requirement for employees to maintain hard copies of procedures in work area.

ENGINEERING FOR A BETTER WORLD

FEEZOR ENGINEERING, INC.

BRIDGETON LANDFILL - WEST LAKE LANDFILL

CORE SAMPLING (PHASES 1B, 1C, AND 2)
HEALTH AND SAFETY PLAN

BRIDGETON, ST. LOUIS COUNTY, MISSOURI

Prepared For:
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December 18, 2013

Project No.: BT-012

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Core Sampling Health and Safety Plan (Phases 1B, 1C, and 2)

Bridgeton Landfill, LLC

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1 INTRODUCTION

This Health and Safety Plan (HSP) was developed for Feezor Engineering, Inc. (FEI) employees and subcontractors under agreement with FEI for subsurface investigations in the southern portion of Operable Unit 1 (OU-1), Radiological Area 1 (Area 1) of the West Lake Landfill Superfund site immediately to the north of Permitted North Quarry Landfill at the Bridgeton Landfill. As described in the Core Sampling Work Plan (Phases 1B, 1C and 2) [FEI, 2013a], subsurface investigations are being conducted to obtain data necessary to identify a proposed alignment and develop design information for an isolation/thermal barrier that would prevent migration of a subsurface smoldering event (SSE), if one were to ever occur, within Bridgeton Landfill's North Quarry Landfill into the adjacent Radiological Area 1 of the West Lake Landfill Superfund site.

The purpose of this HSP to provide background information and establish standard personal protection standards and health and safety policies/procedures for work practices of FEI and Subcontractor employees during performance of subsurface investigations along the south side of Area 1. Prior to any work, a copy of this HSP will be distributed to all FEI employees and subcontractor personnel involved with this work. Prior to anyone beginning work, they will be required to read this HSP and sign the Compliance Agreement included in Appendix A.

The levels of protection and the procedures specified in this HSP are based on information available at this time, and represent the minimum health and safety requirements to be observed by all FEI and Subcontractor employees while engaged in this project. Unforeseeable site conditions may warrant the use of higher levels of protection. Subcontractors are required to provide the necessary safety equipment and safety training to their personnel in compliance with the Occupational Safety and Health Administration (OSHA) regulations provided in 29 CFR 1926.

The content of this HSP may change or undergo revision as additional information is obtained during the field activities. Any changes to this HSP must be reviewed by the Project Health and Safety Officer and are subject to approval by the Project Manager.

Field personnel must read this document carefully. If you have any questions or concerns that you feel are not adequately addressed, ask your supervisor or the Project Health and Safety Officer. Follow the designated health and safety procedures, be alert to the hazards associated with working on any construction site in close proximity to heavy equipment, and above all else, use common sense and exercise reasonable caution at all times.

The HSP is organized as follows:

- Section 2 describes the project safety personnel;
- Section 3 provides information regarding the West Lake Landfill site;

- Section 4 summarizes the field activities to be conducted as part of the subsurface investigations;
- Section 5 presents an evaluation of the hazards that may be encountered during the performance of the field activities and includes control measures for the hazards;
- Section 6 includes general training requirements;
- Section 7 describes the general health and safety procedures to be employed during the field activities; and
- Section 8 lists the emergency contacts and the procedures to be implemented in the event of an accident or other emergency.
- Section 9 provides a list of references.

2 PROJECT SAFETY PERSONNEL

Personnel responsible for project safety during performance of the subsurface investigations along the south side of Area 1 are the Project Manager, the Project Health and Safety Officer, the Radiation Safety Officer, and the On-Site Health and Safety Officer for each subcontractor.

The Project Health and Safety Officer has responsibility for establishing appropriate health and safety procedures for the project (as presented in this Health and Safety Plan) and has the authority to implement those procedures including, if necessary, the authority to temporarily shut down the project for health and safety reasons. The Radiation Safety Officer will be responsible for radiological safety training to contractor and subcontractor workers and site visitors; radiological surveying of drill sites, access roads, equipment, and personnel; gamma logging and soil core scanning; and radiological health and safety monitoring. The On-site Health and Safety Officer for each subcontractor will be responsible for assuring that the procedures specified in this Health and Safety Plan are implemented in the field and also has the authority to temporarily shut down the project for health and safety reasons. The Project Manager will have overall responsibility for project health and safety and has the authority to take whatever actions may be necessary to provide a safe working environment for FEI and Subcontractor personnel. The personnel fulfilling these responsibilities and their mobile telephone numbers are included in Table 1.

The Bridgeton Landfill and West Lake Landfill (see descriptions of these landfills in Section 3) are located on an approximate 200-acre site. Bridgeton Landfill, LLC, a subsidiary of Republic Services, Inc. is conducting closure/post-closure activities at the Bridgeton Landfill and operates a solid waste transfer station at the site. In addition to the project-specific personnel listed above, the on-site Environmental Manager for Republic Services has authority to decide on the continuation or stoppage of all work being conducted on the 200-acre site.

The ultimate responsibility for the health and safety of the individual employee rests with the employee. Each employee is responsible for exercising the utmost care and good judgment in protecting his or her own health and safety, and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of their fellow employees and the appropriate health and safety personnel.

Should an employee find himself or herself in a potentially hazardous situation, the employee shall immediately discontinue the hazardous procedure(s) and personally take appropriate preventative or corrective action, and immediately notify the Project Health and Safety Officer of the nature of the hazard. Any site personnel may stop any work activity that is assessed to be an imminent safety hazard, emergency situation, or other potentially dangerous situation. Once work has been halted for any safety reason, the On-site Health and Safety Officer for the specific contractor and Project Manager must be notified immediately by the party calling for the stop. The reasons for the work stoppage will be discussed with the Project Health and Safety Officer and the Project Manager. The Project Manager will make the decision as to whether work may continue or if actions need to be taken to correct an unsafe situation or activity.

3 SITE INFORMATION

This section includes discussions on the site location and surrounding areas, historical landfill operations and disposal areas, the Superfund Operable Units, and current site uses. Information regarding climate in the area and surface water runoff drainage patterns are also provided.

3.1 SITE LOCATION AND SURROUNDING AREA

The site includes the permitted North and South Quarry Landfills that make up the Bridgeton Sanitary Landfill and the former Demolition Landfill, Inactive Sanitary Landfill and Radiological Areas 1 and 2 that make up the West Lake Landfills. The site is located within the western portion of the St. Louis metropolitan area approximately two miles east of the Missouri River. The site is located approximately one mile north of the intersection of Interstate 70 and Interstate 270 within the city limits of the City of Bridgeton in northwestern St. Louis County.

The site is bounded to the east and northeast by St. Charles Rock Road (State Highway 180) [Figure 1]. Commercial and industrial properties bound the site immediately to the north, across St. Charles Rock Road to the north and east, and to the south. The site is bounded on the west by Old St. Charles Rock Road (vacated) and the Earth City Industrial Park stormwater/flood control pond. The Earth City commercial and industrial complex continues to the west and north of the stormwater/flood control pond and extends from the site to the Missouri River. Earth City is separated from the Missouri River by an engineered levee system.

3.2 HISTORIC LANDFILL OPERATIONS AND DISPOSAL AREAS

The West Lake Landfill is an approximately 200-acre parcel containing multiple areas of past operations. The site was used agriculturally until a limestone quarrying and crushing operation began in 1939. The quarrying operation continued until 1988 and resulted in two quarry pits, the North Quarry Pit and the South Quarry Pit (Figure 1), which were excavated to maximum depth of 240 feet below ground surface (bgs) [Herst & Associates, 2005].

The West Lake Landfill is the site of several areas where solid wastes have been disposed. Beginning in the early 1950s or perhaps the later 1940s, portions of the quarried areas and adjacent areas were used for landfilling municipal refuse, industrial solid wastes, and construction/demolition debris. The Bridgeton Sanitary Landfill waste mass encompasses approximately 52 acres with approximately 240 feet below the ground's surface and a total waste thickness of 320 feet. The waste is located in two distinct areas known as the North and South Quarry Permitted Landfill cells. The Bridgeton Sanitary Landfill was initially permitted on Nov. 18, 1985. Waste disposal activities in these areas began with filling of the North Quarry Landfill and continued with placement of solid wastes progressing to the south until the South Quarry Landfill was filled. Waste disposal activities at the Bridgeton Landfill ceased on Dec. 31, 2004 pursuant to an agreement with the City of St. Louis to reduce the potential for birds to interfere with airport operations. A final soil cover was subsequently placed over the North and South Quarry Permitted Landfill cells. In 2013, a geosynthetic cover composed of a green 60 mil Ethylene Vinyl Alcohol (EVOH) liner was installed over the South Quarry Landfill to reduce the potential for odor emissions. Enhancements to the landfill gas extraction and leachate collection systems at the South Quarry Landfill were also installed prior to and during that cover installation. The Bridgeton Sanitary Landfill is inactive and closure/post-closure activities are proceeding under Missouri Department of Natural Resources (MDNR) supervision.

In addition to the Bridgeton Sanitary Landfill North and South Quarry Permitted Landfill cells, the West Lake Landfill property contains four other areas where solid wastes were disposed (Figure 1):

- Area 1 where solid wastes and radiologically-impacted materials were disposed;
- Area 2 where solid wastes and radiologically-impacted materials were disposed;
- A closed demolition landfill; and
- An inactive sanitary landfill.

3.3 SUPERFUND OPERABLE UNITS

Superfund-program remedial action at the site is divided into two operable units (OUs). OU-1 is comprised of the solid wastes and radiologically-impacted materials disposed in Areas 1 and 2 and portions of an adjacent property, the Buffer Zone/Crossroad Property.

OU-2 consists of the other landfill areas that are not impacted by radionuclides and includes the inactive sanitary landfill located adjacent to Area 2, the closed demolition landfill, and the Bridgeton Sanitary Landfill Permitted Landfill cells. The closed demolition landfill and the Bridgeton Sanitary Landfill, while designated as part of OU-2, are regulated by the MDNR pursuant to State of Missouri solid waste regulations and are not being actively addressed by the Superfund program.

Area 1 is situated on the northern and western slopes of a topographic high within the overall West Lake landfill property. Ground surface elevation in Area 1 varies from 490 feet above mean sea level (AMSL) on the south to 452 feet AMSL at the roadway near the transfer station entrance (Figure 2).

Area 2 is situated between a topographic high of landfilled materials on the south and east, and the Buffer Zone/Crossroad Property on the west. The highest topographic level in Area 2 is about 500 feet AMSL on the southwest side of Area 2, sloping to approximately 470 feet AMSL near the top of the landfill berm (Figure 1). The upper surface of the berm along the western edge of Area 2 is located approximately 20 to 30 feet above the adjacent Buffer Zone/Crossroad Property and approximately 30 to 40 feet higher than the water surface in the flood control channel located to the south-west of Area 2. A berm on the northern portions of Area 2 controls runoff to the adjacent properties.

Municipal solid waste, construction and demolition debris, quarry spoil material and possibly other wastes were disposed of in Areas 1 and 2. Reportedly, 38,000 to 39,000 tons of soil were mixed with approximately 8,700 tons of leached barium-sulfate residue, and of this amount, 43,000 tons were sent to West Lake Landfill over the period from July through October 1973 (Nuclear Regulatory Commission [NRC], 1976 and 1988 and RMC, 1982). Post-disposal investigations by the NRC suggest that the 43,000 tons of soil mixed with leached barium-sulfate residue were spread and used as cover material for the landfill operations. Per the NRC, "This material was hauled to the landfill area and used as cover for part of the several hundred truckloads of garbage and refuse that are shipped to the landfill area site every week." Landfilling of waste materials continued to be performed both during and after disposal of the radiologically-impacted soil mixture.

Radiological constituents in Areas 1 and 2 occur in soil materials that are intermixed with and interspersed within the overall matrix of landfilled refuse, debris and fill materials, and unimpacted soil and quarry spoils. In some portions of Areas 1 and 2, radiologically-impacted materials are present at the surface; however, the majority of the radiological occurrences are present in the subsurface beneath these two areas. At the Buffer Zone/Crossroads properties the radiologically-impacted materials are found in soils believed to have been carried by erosion from the Area 2 berm prior to growth of the current on-site vegetation.

In general, the primary radionuclides detected at levels above background concentrations at the West Lake Landfill are part of the uranium-238 and uranium-235 decay series. Thorium-232 is also present above background levels but at a lesser frequency.

3.4 Current Site Uses

The West Lake Landfill is located in a predominantly industrial area. The entire landfill area, including the areas investigated under OU-1 and OU-2, has been the site of historic quarry operations to remove limestone, and landfill operations. Other activities on the OU-2 portion of the property include a solid waste transfer facility, concrete and asphalt batch plant operations, and an auto repair facility (Figure 1).

With the exception of the Buffer Zone, all of the site area has previously been developed and was used for or in conjunction with disposal of solid wastes at the site or is currently being used in conjunction with the various industrial operations conducted at the Site. Areas 1 and 2, the closed demolition landfill, the inactive sanitary landfill, and the former Bridgeton Sanitary Landfill located in the North and South Quarry Permitted Landfill cells (Figure 1) were all used for disposal of solid wastes. Current activities in these areas consist of maintenance of the landfill covers and environmental monitoring. Extraction of leachate continues to be performed on an ongoing basis from the North and South Quarry Permitted Landfill cells.

In addition to the area containing the transfer station entrance road and site office trailer/weigh station, there are two areas located outside of the solid waste disposal units in which industrial activities are conducted at the site. These include the area in the central portion of the site where the solid waste transfer station and the concrete and asphalt batch plants are located, and a small area near the southwestern portion of the site in which an automobile repair facility is located (Figure 1). In addition to these areas, the Republic Services district office and refuse collection vehicle parking and repair lots are located outside of but adjacent to the site. The landfill stormwater retention pond and OU-2 on-site soil borrow and stockpile area are also located on property outside of but adjacent to the site (Figure 1).

3.5 CLIMATE AND METEOROLOGY

The climate of the landfill area is typical of the Midwestern United States with a modified continental climate that has four distinct seasons.

Winter temperatures are generally not severe with the first frost usually occurring in October and freezing temperatures generally not persisting past March. Records since 1870 show that temperatures drop to zero °F or below an average of two or three days per year. Temperatures remain at or below freezing less than 25 days in most years. Summers in the St. Louis area are hot and humid. The long-term record since 1870 indicates that temperatures of 90 degrees Fahrenheit or higher occur on about 35 to 40 days per year. Extremely hot days of 100 degrees Fahrenheit or more generally occur no more than five days per year.

Normal annual precipitation as measured at nearby Lambert Field International Airport based on records dating back to 1871 is a little less than 34 inches. The three winter months are usually the driest, with an average total of approximately 6 inches of precipitation. Average snowfall per winter season is slightly greater than 18 inches. Snowfall of an inch or more is received on five to ten days in most years. Record snowfall accumulation over the past 30 years was 66.0 inches recorded during the 1977 –78 winter season. The spring months of March through May are the wettest with normal total precipitation of just under 10.5 inches. Thunderstorms normally occur 40 to 50 days per year. During any given year, a few of these storms can be classified as severe with hail and damaging wind. Tornadoes have occurred in the St. Louis area.

Between December and April, the predominant wind direction at Lambert Field is from the northwest and west-northwest. Throughout the remainder of the year, the predominant wind direction is from the south. Considering potential differences in topography between Lambert Field and the West Lake Landfill, the actual wind directions at the landfill may be slightly different, possibly skewed in a northeast-southwest direction parallel to the Missouri River valley.

4 DESCRIPTION OF WORK

4.1 OVERALL SCOPE AND APPROACH OF THE INVESTIGATION

In order to select an alignment and develop the design plans for the isolation/thermal barrier, additional subsurface data are needed between known extent of the RIM within West Lake OU-1 Area 1 and the Bridgeton Landfill - North Quarry Area. Phase 1 of the project used Cone Penetration Tests (CPTs) to determine the characteristics of the subsurface materials within proposed alignments of the isolation/thermal barrier and the southern edge of the Area 1 fence. The CPT device was also capable of measuring gamma counts which can increase the likelihood that the proposed isolation/thermal barrier can be constructed without encountering RIM. Regardless of the investigation results, radiological scanning will occur during the barrier excavation to ensure RIM is not being relocated.

Consistent with EPA direction, the Phase 1 Gamma Cone Penetration Test (GCPT) investigation was the first of what was initially envisioned as a two phased investigation to confirm the isolation/thermal barrier location. The Phase 1 GCPT investigation was to be used to identify a potential alignment and obtain initial geotechnical data for a potential isolation/thermal barrier and was to be followed by a Phase 2 investigation that would confirm the results obtained from the Phase 1 GCPT investigation and further verify the suitability of the proposed alignment. The assumption underlying this approach was that the initial phase (Phase 1 GCPT) of work would not encounter RIM beneath the area of the potential alignment of the isolation/thermal barrier.

Review of the results of the GCPT work indicated that RIM may be present beneath the southwestern portion of Area 1 in the area of possible preferred alignments for an isolation/thermal barrier. Specifically, elevated gamma readings were obtained from depth intervals of approximately 25 to 35 feet (ft) below ground surface (bgs) in ten (10) of the GCPT soundings drilled in the southwestern portion of Area 1.

Because initial evaluation of the results of the Phase 1 GCPT investigation suggest that RIM may be present beneath the southwestern portion of Area 1, additional investigations prior to identification of a potential alignment for an isolation/thermal barrier are needed. Borehole drilling and collection and laboratory analyses of soil/waste samples from this area are necessary to obtain information regarding the nature of the waste materials associated with the elevated gamma readings and to verify that the elevated gamma levels reported in borings drilled in the southwestern portion of Area 1 reflect the presence of RIM (in contrast to the possible presence of some other material) in this area. In addition, as previously indicated, many of the GCPT soundings drilled in the southeastern portion of Area 1 encountered refusal at shallow depths.

Consequently, an additional phase (Phase 1B) of investigation is proposed prior to identification of a potential alignment for an isolation/thermal barrier. Phase 1B work would include drilling of additional borings, downhole gamma logging in the borings, and sampling the material responsible for the elevated gamma readings observed in the Phase 1 GCPT borings drilled in the area. Assessing why many of the GCPT soundings drilled during Phase 1 along the east side of the southern portion of Area 1 encountered refusal at shallow depths would also be conducted during Phase 1B. Assuming the material responsible for the elevated gamma readings in the southwestern portion of Area 1 is RIM, a subsequent phase of investigation (Phase 1C) is also envisioned to define the limits of this RIM prior to selection of an alignment for an isolation/thermal barrier. A Phase 2 core sampling investigation would confirm the characteristics (concentrations of isotopic elements, geotechnical data, and nature of fill materials) of the subsurface material along the proposed isolation/thermal barrier alignment.

4.2 Goals of the Investigation

The goals and objectives and overall scope of the various phases of the investigation are described below. To minimize delay between the various phases of the investigations, the EPA has requested an expedited development of a Work Plan that addresses the additional Phase 1 investigations and the Phase 2 investigation. At the time the accompanying work plan is being authored, the results of the Phase 1 GCPT work are still being evaluated. Therefore, the accompanying work plan is focused on the scope and procedures to be utilized to conduct the Phase 1B investigation. In order to expedite performance of the subsequent investigations, the accompanying work plan also describes the general scope and anticipated approach envisioned for the subsequent phases of the investigation. The procedures and protocols described in the accompanying work plan and the previous Phase 1 work plan (FEI, 2013b) will also be used for the subsequent Phase 1C and Phase 2 investigations.

4.2.1 Phase 1 GCPT

Phase 1 of the investigation was focused on collection of information south of and, in some locations, up to the projected extent of RIM material occurrences, in order to confirm the absence of RIM in the location selected for the potential isolation/thermal barrier alignment. The goals of the Phase 1 investigation were to provide confirmatory observations that material within the proposed excavation area for the potential isolation/thermal barrier alignment does not contain RIM and to gather the required geotechnical data for design of the barrier.

The primary goals of the GCPT investigation (Phase 1) were to:

- Determine the stratigraphy, nature, and geotechnical properties of subsurface materials for design purposes,
- Determine liquid levels,
- Determine if any RIM exists within the potential barrier excavation footprint,
- Determine depth to native material, and
- Use the above information to select the best alignment for the barrier (proposed alignment).

4.2.2 Phase 1B – Completion/Confirmation Investigation

Initial review of the results of the Phase 1 investigation indicates that previously unidentified RIM may be present beneath the southwestern portion of Area 1. Specifically, elevated gamma readings were measured in GCPT soundings drilled in the southwestern portion of Area 1. One of the goals of the Phase 1B investigation is to obtain samples for laboratory analyses of the eight known isotopes associated with the RIM in OU-1. Therefore, Phase 1B will include drilling of soil borings, performance of downhole gamma logging of the soil borings, collection of samples of the specific material responsible for the elevated gamma readings observed in the Phase 1 GCPT soundings drilled in this area, visual inspection and description of the material associated with the elevated gamma readings, and submission of samples to an offsite analytical laboratory for radioisotope analyses.

Furthermore, many of the GCPT soundings drilled along the east side of the southern portion of Area 1 (e.g., those included in alignments 13 and 14 – see Figure 2) encountered refusal at shallow depths. The cause of this refusal could not be determined from the GCPT work. It may be due to the presence of construction and demolition debris in this area or alternatively may reflect the presence of shallow bedrock in this area. Data regarding the base of the OU-1 landfill wastes are needed in this area. Therefore, additional drilling is required to evaluate the nature of the materials responsible for GCPT refusal in this area and to verify the absence of RIM and obtain geotechnical data necessary for selection of a potential alignment for an isolation/thermal barrier through this area (i.e., to complete the objectives of Phase 1). Therefore, several soil borings will be drilled in this area using a drilling method that should be capable of drilling through any construction and demolition debris or the upper portion of any bedrock that may be present in this area to ensure that drilling extends through the entire thickness of refuse in this area.

It also necessary to obtain laboratory analytical data from known, unimpacted boring locations to assist with determination of background gamma levels and radioisotope activities associated with non-RIM waste and in situ soils. Therefore, soil/waste samples will be obtained from Phase 1B borings drilled in the eastern portion of Area 1 that do not display elevated downhole gamma readings. Samples will also be obtained from any borings/depth intervals where elevated gamma readings are encountered in the boreholes drilled in the eastern portion of Area 1.

4.2.3 Phase 1C – Delineation of the Extent of RIM

In order to select a proposed alignment for an isolation/thermal barrier, additional characterization of the area of elevated gamma readings in the southwestern portion of Area 1 will likely need to be performed, presuming that the results of the Phase 1B investigation indicate that these readings reflect the presence of RIM in this area. Although the logical approach for such an investigation would be to perform additional GCPT soundings outside of this area, use of the GCPT drilling technique may not ensure complete delineation of the extent of elevated gamma readings in this area. Besides the potential for refusal at depths less than the full depth of refuse as encountered in the eastern portion of Area 1, drilling to define the extent of RIM may necessitate drilling along and through the slope of the North Quarry Landfill, the waste deposits of which overlap the southernmost portion of Area 1. The depth of drilling required in this area could potentially exceed the maximum effective depth of the GCPT drilling rig (approximately 70 to 100 ft). Therefore, delineation of the extent of possible RIM in the southwestern portion of Area 1 may require performance of sonic drilling or a combination of GCPT and sonic drilling. The proposed approach for completion of this delineation will be addressed in an addendum to the accompanying work plan.

4.2.4 Phase 2 Core Sampling Investigation

The objective of Phase 2 of this project is to collect and analyze soil core samples for the presence or absence of RIM as well as to confirm the characteristics of the subsurface material along the proposed barrier alignment determined from the GCPT at a limited number of locations. The Phase 2 investigation will also be used as a verification of the GCPT methodology and interpretations for the geotechnical data.

Based on the results of the Phase 1 investigations, an initial conceptual design for an isolation/thermal barrier will be developed. The initial conceptual design will include a summary and evaluation of the Phase 1 investigation results, a proposed alignment for the isolation/thermal barrier, the anticipated barrier technology, and the general approach anticipated to be used for installation of the barrier. Based on the initial conceptual design, additional data necessary for finalization of the proposed alignment, isolation/thermal barrier design, and construction techniques will be identified. Currently it is anticipated that the isolation/thermal barrier will be installed by excavation of refuse followed by placement of an earthen barrier along the north side of the excavation, followed by backfilling of the remainder of the excavation with refuse removed from other portions of the excavation. Upon completion, the EVOH cap being installed over the North Quarry Landfill will be extended over the isolation/thermal barrier and excavation areas.

Assuming the isolation/thermal barrier is constructed by excavation of existing refuse, the primary goal of the Phase 2 Core Sampling investigation will be to quantify subsurface concentrations of isotopic elements within the isolation/thermal barrier construction area. This will involve:

- Installation of a sufficient number of boreholes to verify the GCPT data within the isolation/thermal barrier excavation limits~~,~~
- Produce geophysical and radiometric logging data from each soil core,
- Collect samples of soil materials from each length of the borehole (minimum 2 per borehole),
- Generate down hole gamma logs that will be used to prioritize sample analysis from the borehole samples collected,
- Submit soil samples to a certified, independent laboratory for radioanalyses,

- Determine type of waste/subsurface material (e.g., rock, municipal solid waste, construction and demolition waste), and
- Determine the necessary chemical analyses of the Investigation Derived Wastes, so that the soil cores may be properly disposed after all analytical testing has concluded.

The design process will use the results of the Phase 1 investigations to conceptually design the isolation/thermal barrier. Data such as depth of waste, liquid levels, width of isolation/thermal barrier, allowable slopes, and staging requirements will be used in the alignment and “daylight” line projections, which will guide the coring location selection.

5 HAZARD EVALUATION AND CONTROLS

There exists a limited potential for biological, physical, chemical, and radiological hazards during implementation of the Core Sampling (Phases 1B, 1C and 2) investigations at the West Lake Landfill site. An activity-specific hazard analysis and control measures to mitigate the potential hazards are included in this section.

5.1 BIOLOGICAL HAZARDS

Possible biological hazards include venomous insects (e.g., bees, wasps, spiders) that can produce allergic reactions; plants such as poison ivy, oak, and sumac that elicit allergic skin reactions in sensitive individuals, and other invertebrates such as fire ants and biting flies which can produce painful irritations. Exposure to these hazards will be minimized with appropriate protective clothing.

5.2 PHYSICAL HAZARDS AND CONTROLS

Physical hazards that may be encountered include:

☒ Slip/trip/fall hazards	☒ Head hazards	☒ Eye hazards
☒ Thermal stresses	☒ Foot hazards	☒ Hand hazards
☒ Mechanical hazards	☒ Electrical hazards	☒ Fire and explosion
☒ Falling objects	☒ Heavy equip hazards	☒ Extreme weather
☒ Excavation hazards	☒ Material handling	☒ High noise levels

Control measures for these physical hazards are provided in Table 2 and in Section 7.

5.3 CHEMICAL HAZARDS AND CONTROLS

5.3.1 Fuel for Equipment

Fuels that will be used during the work activities include diesel fuel and gasoline. In addition to the information below regarding these chemicals, refer to the National Institute for Occupational Safety and Health (NIOSH) Guide to Chemical Hazards.

Chemical Name	Concentration	Exposure Limits REL/PEL (8/10 hr/day; 40 hr/ wk)	IDLH	MSDS if (available)	OSHA Carcinogen	Routes of Exposure *
Diesel fuel	NA	300 ppm	900 ppm	Yes	Yes	Inh, Abs, con

Gasoline	NA	300 ppm	900 ppm	Yes	No	Inh, abs, con

NA – not applicable, REL – Recommended Exposure Limit, PEL – Permissible Exposure Limit, IDLH – Immediately Dangerous to Life & Health, ppm – parts per million, MSDS - material safety data sheet
Routes of Exposure: Inh – Inhalation, Abs – Skin Absorption, Ing – Ingestion, Con – Contact (Skin / Eye)
The Thirteen OSHA –Regulated Carcinogens are found in Appendix B, NIOSH Guide to Chemical Hazards

Material Safety Data Sheets (MSDSs) for diesel fuel and gasoline that include control measures for these fuels are provided in Appendix B.

5.3.2 Landfill Gases

In the unlikely event that landfill gas is encountered during investigation activities, workers should be aware that landfill gas may contain methane, carbon monoxide, hydrogen, carbon dioxide, ammonia, organic compounds, and hydrogen sulfide. The potential fire or explosion hazards from common landfill gas components and health effects from oxygen deficient environments are listed below.

Potential Fire or Explosion Hazards from Common Landfill Gas Components

Component	Potential to Pose a Fire or Explosion Hazard
Methane	Methane is highly explosive when mixed with air at a volume between its Lower Explosive Limit (LEL) of 5 % and its Upper Explosive Limit (UEL) of 15%. At concentrations below 5% and above 15%, methane is not explosive.
Hydrogen	Hydrogen is highly explosive when mixed with air at a concentration between its LEL of 4 % and UEL of 74.5 %.
Carbon Monoxide	Carbon monoxide is explosive when mixed with air at a concentration between its LEL of 12.5 % and UEL of 57 %.
Carbon dioxide	Carbon dioxide is not flammable or explosive.
Nitrogen	Nitrogen is not flammable or explosive.
Oxygen	Oxygen is not flammable, but is necessary to support combustion.
Ammonia	Ammonia is flammable. Its LEL is 15% and its UEL is 28%. However, ammonia is unlikely to collect at a concentration high enough to pose an explosion hazard.
NMOCs	Potential explosion hazards vary by chemical. For example, the LEL of benzene is 1.2% and its UEL is 7.8%. However, benzene and other non-methane organic compounds (NMOCs) alone are unlikely to collect at concentrations high enough to pose explosion hazards.
Hydrogen sulfide	Hydrogen sulfide is flammable. Its LEL is 4% and its UEL is 44%. However, in most landfills, hydrogen sulfide is unlikely to collect at a concentration high enough to pose an explosion hazard.

Health Effects from Oxygen-deficient Environments

Oxygen Concentration	Health Effects
21%	Normal ambient air oxygen concentration
17%	Deteriorated night vision (not noticeable until a normal oxygen concentration is restored), increased breathing volume, and accelerated heartbeat
14% to 16%	Increased breathing volume, accelerated heartbeat, very poor muscular coordination, rapid fatigue, and intermittent respiration
6% to 10%	Nausea, vomiting, inability to perform, and unconsciousness
Less than 6%	Breathing spasms, convulsive movements, and death in minutes

An on-site worker selected by the Project Health and Safety Officer will wear a personal 4-gas meter while conducting project activities. The meter will be capable of monitoring oxygen, explosive gas levels, carbon monoxide, and hydrogen sulfide. If monitoring detects explosive levels of landfill gas 18 inches to 2 feet above the waste surface, work will be halted until the gas dissipates and/or fans are applied to the work area to ensure the gas dissipates before reaching explosive concentrations.

5.3.3 Hazardous Wastes

Volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) might be encountered during advancement of the drilling of borings to obtain the core samples. A hazard assessment of compounds of concern that might be encountered is provided in Table 3.

Regular monitoring for the presence of VOCs will be conducted by the Project Health and Safety Officer or Radiation Safety Officer and changes made as necessary to the initial level (Level D; see Section 7.2) of skin and respiratory personal protective equipment (PPE). A photoionization detector (PID) with an 11.7 eV lamp will be used to monitor for VOCs in the breathing zone and the soil surface where the investigation activities are occurring. The borehole, any geological samples, and drill cuttings will also be monitored upon their retrieval with the PID. PID and multi-gas monitoring (see Section 5.3.2) will be conducted every 15 minutes for the first 2 hours of a specific activity and then at least every 120 minutes during active work.

To maintain safe working conditions, if vapor concentrations in the breathing zone consistently exceed 5 ppm (instrument gauge units) based on PID measurements, then an upgrade from initial Level D to Level C PPE will be made. Level C PPE will require the addition of a Tyvek suit, disposable nitrile gloves, and a National Institute of Occupational Safety and Health ("NIOSH") approved full-face respirator with organic vapor/acid gas cartridges and dust/mist pre-filters. All personnel performing work in Level C must be fit-tested and trained in the proper use of respirators.

5.3.4 Asbestos

The inhalation of friable asbestos fibers by workers can cause disease of the lungs and other organs that may not appear until years after the exposure has occurred. In the event that friable asbestos is encountered during core sampling activities, the on-site personnel will have been appropriately trained regarding asbestos awareness and recognition. Appropriate personnel will be notified as to the location of confirmed or presumed asbestos containing materials. Any confirmed asbestos containing materials will be handled by personnel with appropriate training to handle such material. Documentation as to the handling procedures and disposition of the friable asbestos containing material will be maintained in the project files.

5.4 RADIOLOGICAL HAZARDS AND CONTROLS

5.4.1 Radiological Hazards

All radiological hazards are associated with the radiologically-impacted soil within Area 1. The radionuclides are primarily comprised of isotopes of thorium and radium and their decay products. Potential exposures from working with and on top of radiologically-impacted soil include:

- External (Direct) Exposure. The radiologically-impacted soil on the surface will emit penetrating radiation in the form of gamma rays.
- Internal Exposure. Internal exposures occur when a worker ingests impacted soil or inhales dust containing radioactive particles.
- Spreading Contamination. It is likely that clothing and tools that contact radiologically-impacted surface soil within the extent of radiologically-impacted material in Areas 1 and 2 could become contaminated. The dose for such radiological contamination is likely to be very low. To prevent potentially contaminated materials from being carried to vehicles and off-site locations, the materials should be examined with a radiation ratemeter-scaler coupled to a pancake detector (e.g., Ludlum Model 44-9). The standard procedure for monitoring personnel and equipment for radioactive contamination is provided in Appendix C.

5.4.2 Radiological Controls

The purpose of the radiological hazard controls is to lay out procedures that will avoid any significant exposure to the workers involved with the core sampling investigation. During the initial safety meeting, workers will be apprised of the radiological contamination hazard both in extent and degree. The controls to be used to mitigate the hazard will then be presented.

The goal of the core sampling Phase 2 project is to confirm the absence of RIM in the proposed area in which the isolation/thermal barrier will be constructed. Consequently, boring locations are planned to be in an area where no RIM has previously been identified or is otherwise expected to be present.

Because the core sampling personnel and gamma scan personnel may potentially encounter RIM, a potential risk exists for these workers to be exposed to radiation. Such exposures will be limited by the use of appropriate personnel protective equipment (e.g., boots, gloves, safety glasses, etc.) and adherence to the procedures set forth in this HSP in particular the frisking and decontamination procedures. These workers will be required to wear personal dosimetry while completing their work and will be issued a Thermoluminescent Detector (TLD) by the site Radiation Safety Officer. Each TLD will be assigned to a specific individual and can only be worn by that person. Dosimeters will be collected each night by the site Radiation Safety Officer or his delegate and reissued the following day. When a TLD is issued, the recipient will be briefed on the use and care of the dosimeter. Dosimeters shall be worn on the chest area, on or between the waist and the neck. Dosimeters shall not be exposed to security x-ray devices, excessive heat, or medical sources of radiation. If a dosimeter is lost or damaged, the worker should immediately report the loss to the site Radiation Safety Officer. If the Radiation Safety Officer decides to issue Electronic Personal Dosimeters, they will be collected and read at the end of each shift. Results from Electronic Personal Dosimeters will be considered monitoring data. Doses of record will be determined from the TLDs.

It is important that all workers understand they may become exposed if they leave the gravel roads/drill pads and enter the area of RIM occurrences within Area 1 without training and appropriate health and safety equipment and procedures. If a worker suspects that they may have contacted surface soil in a radiologically-impacted area (e.g., soil collected on the bottom of work boots), the potentially contaminated area will be scanned with a radiation ratemeter-scaler coupled to a pancake detector. If the scan indicates the collected soil is contaminated, the contaminated surface should be washed with water and the soil/water solution collected in a plastic container or bag.

6 TRAINING

On-site workers will have received hazardous waste operations and emergency response (HAZWOPER) training in accordance with 29 CFR 1910.120. These workers will also have received the radiological safety training required in 10 CFR Part 19 which requires that *"…all individuals who, in the course of their employment, are likely to receive a dose of more than 100 millirem in a year, must receive adequate training to protect themselves against radiation."*. This level of training will be conducted even though exposure, if any, for on-site workers is expected to be much less than 100 millirem.

The radiological safety training will meet typical General Employee Radiological Training (GERT) requirements and include:

- The nature of radioactive materials on the Site;
- Potential routes of exposure;
- Types of controls practiced to minimize exposures; including discussion of any engineering controls, administrative use of time, distance and shielding, and personal protective equipment;
- Types of monitoring used to track potential exposures (periodic area surveys, air monitoring, and use of dosimeters);
- Proper use of instrumentation;
- Incident reporting;
- Availability and use of confidential personal dosimetry records;
- Effects of radiation on humans; and
- Allowable limits (who sets them and what they are).

In addition, on-site workers will have been appropriately trained regarding asbestos awareness and recognition.

All personnel performing work described in this HSP must attend a site/project orientation session, conducted by the Project Health and Safety Officer or Radiation Safety Officer. The session will cover, at a minimum, site restrictions, health and safety regulations, required personal protective equipment, potential site hazards, constituents of concern, decontamination and emergency procedures. All personnel attending the site/project orientation session must sign the Compliance Agreement provided in Appendix A of this HSP.

Visitors who stay at the site for less than one hour or subcontractors performing routine work not directly related to work described in this HSP (e.g., delivery of equipment and materials) will not require a health and safety orientation.

Each subcontractor must designate a qualified person to be responsible for the health and safety of their employees, and will cooperate with FEI in implementing this HSP.

7 GENERAL HEALTH AND SAFETY PROCEDURES

This section presents general health safety procedures to be followed during the GCPT investigation activities. The measures contained herein will be supplemented as necessary with standard safe work practices.

7.1 ONSITE CONTROL

Onsite control at Areas 1 and 2 of the West Lake Landfill is currently provided by six-foot high chain-link security fences that surround Areas 1 and 2.

7.2 PERSONAL PROTECTIVE EQUIPMENT – GENERAL WORK

The minimum level (Level D) of PPE required for activities inside Area 1 that support the core sampling investigation will consist of the following:

- Steel-toed boots (mandatory),
- High visibility traffic vest or high visibility work shirt (mandatory);
- Hard hat (mandatory),
- Safety glasses (mandatory),
- Gloves, as necessary based on the specific activity, and
- Hearing protection, as necessary based on the specific activity.

Visitors shall be required to wear PPE equivalent to the above.

7.3 PERSONAL PROTECTIVE EQUIPMENT – PERMITTED WORK

The minimum level (Modified Level D) of PPE required for the core sampling investigation will consist of the following:

- Steel-toed boots (mandatory) with shoe covers or rubber boots with steel toes,
- Hard hat (mandatory),
- Safety glasses (mandatory),
- Tyvec coveralls,
- Gloves, as necessary based on the specific activity,
- Hearing protection, as necessary based on the specific activity, and
- High visibility traffic vest worn outside of Tyvek (mandatory);

Respirators for protection from radionuclide exposure will not be routinely required but will be made available to workers. Respirators for protection from dust inhalation may be used if there are continuous plumes of visible dust from the borehole or soil cores; however this condition is not anticipated to occur. A decision to require use of respirators will be made by the Project Health and Safety Officer or Radiation Safety Officer if conditions are encountered that warrant use of respirators for protection from dust or radionuclides.

Visitors will not be allowed inside the permitted area. Regulatory personnel shall be required to wear PPE equivalent to the above.

7.4 Environmental Monitoring

If it is suspected that a worker or equipment has contacted soil within the radiologically-impacted areas within Area 1, monitoring of the contacted surface will be conducted with a radiation ratemeter-scaler coupled to a pancake detector by the Radiation Safety Officer or his designee.

7.5 Communication

A cellular telephone will be carried by the Project Health and Safety Officer and Radiation Safety Officer at all times. The following standard hand signals will be used in the event that verbal communication becomes impossible:

Hand Signal	Explanation
Hand gripping throat	Out of air, can't breathe
Grip partner's wrist or both hands around waist	Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, I am all right, I understand
Thumbs down	No, negative

7.6 Safe Work Practices and Limitations

Site Activities will be conducted during daylight hours only. The Project Health and Safety Officer must provide permission for field work conducted beyond daylight hours or on weekends and holidays. The Project Manager, Project Health and Safety Officer, or Radiation Safety Officer will review pertinent health and safety matters with onsite personnel in daily health and safety meetings. Additional work practices and limitations are listed as follows:

- All site personnel shall acknowledge in the Compliance Agreement (Appendix A) that they have read, understood, and agree to comply with the HSP.

- In addition to an initial health and safety meeting the project, daily health and safety may be conducted by the Project Manager, Project Health and Safety Officer, or Radiation Safety Officer at the start of each work day to discuss the day's upcoming activities and to address the health and safety procedures to be followed.
- Applicable OSHA guidelines will be followed for all site activities.
- Dress in accordance with the activity-specific level of protection.
- Smoking will be prohibited except in designated areas.
- Any person under a physician's care, taking medication, or those who experience allergic reactions must inform the Project Health and Safety Officer.
- If a single individual is working at the site, they must have a cellular phone on their person that is turned on.
- The wearing of contact lenses for onsite personnel is prohibited by best management practice and OSHA.
- Be aware of symptoms of heat or cold stress, exposure to hazardous chemicals or dangerous atmospheres, and work-related injuries. Standard Operating Procedures for Heat Stress are included in Appendix D.
- If trenching activities are conducted, proper excavation and trenching procedures must be followed as outlined in 29 CFR 1926.650 through .653 (Subpart P. Excavations, Trenching, and Shoring). In particular, the requirements for shoring, sloping, and access/egress must be followed.
- In addition, all underground utilities (gas, electric, water, cable, telephone) at the site must be identified and marked prior to the commencement of any boring, excavation and/or trenching activity. None are expected to be present in Area 1.
- Good personal hygiene practices are especially important when working in the proximity of the potential radiologically-impacted areas within Area 1. Of particular importance is the need to keep fingers away from the face unless they have been carefully washed. Cuts and abrasions should be covered by a band-aid.
- All accidents and hazardous material exposure incidents will be reported on the appropriate forms, included in Appendix A.

7.7 Heavy Equipment

Working around heavy equipment can be dangerous because of the size and power of the equipment, the limited operatory field of vision, and the noise levels that can be produced by the equipment. The following practices shall be followed by operators when using heavy equipment:

- Equipment should be inspected daily by the operator to ensure that the equipment is in safe operating condition.

- When not in use, hydraulic and pneumatic components should be left in down or "dead" position.
- Roll-over protection shall be provided on uneven terrain sites.
- No riding on vehicles or equipment except in fixed seats.
- Seat belts should be worn at all times.
- Backup alarms, automatically activated and loud enough to be heard above background noise, are required to be operational on all heavy equipment.
- Parking brakes should always be applied on parked equipment.
- Equipment should never be operated closer than 10 feet from utility lines.
- Windshields must be maintained, clean, and free of visual obstructions.

To ensure the safety of personnel in the work area, the following safety procedures regarding heavy equipment must be reviewed prior to and followed during work activities:

- Ensure that equipment operators are trained and/or experienced in the operation of the specific equipment.
- Personnel should never approach a piece of heavy equipment without the operators' acknowledgment and stoppage of work or yielding to the employee.
- Never walk under the load of a bucket or stand beside an opening truck bed.
- Maintain visual contact with the operator when in close proximity to the heavy equipment.
- Wear hearing protection while on or around heavy equipment, when normal conversation cannot be heard above work operations.
- Steel-toed shoes, safety glasses, and a hard hat shall be worn for all work conducted near heavy equipment.

7.8 Drill Rig Safety

Common drill rig safety protocols include the following:

- Understand and practice proper inspection and maintenance of all tools and equipment associated with the drilling activities.
- Only use hand tools for their intended purpose.
- If a tool becomes damaged, it must either be repaired or replaced.
- Maintain a neat work area around the drill rig and associated equipment, practice-proper housekeeping,

- Inspect the drill rig daily for structural damage; loose guards; and damaged hoses, cables, gauges, and valves.
- Check and test all safety devices at the start of each shift.
- NEVER drive a drill rig with the derrick in the upright position.
- Before raising the derrick check for overhead obstructions.
- Before raising the mast the rig must be stabilized with leveling jacks and leveled once the derrick is upright.
- Adequately protect any open holes to prevent anyone from stepping in the hole.
- Terminate drilling operations during an electrical storm and move to a safe location.

Sonic drilling safety precautions include the following:

- When handling rods and casing use winches and hoist plugs to move drill tools from support truck or storage racks into place
- Operator should double check pipe alignment and location of helpers hands before engaging rotation to thread together drill tools
- Never touch rotating rods or casing when they are being threaded together or at anytime.

7.9 Heavy Lifting

When lifting objects, use the following proper lifting techniques:

- Keep your feet shoulder width apart to get the best footing possible.
- Bend at the knees, not at the waist.
- Tighten stomach muscles to offset the force of the load.
- Grasp the object at opposite corners.
- Lift with the legs instead of the back muscles.
- Keep the back upright and avoid twisting.
- Most importantly, think before lifting.

7.10 Slip/Trip/Hit/Fall

Slip, trip, hit, and fall injuries are the most frequent of all injuries to workers. They occur for a wide variety of reasons, but can be minimized by the following prudent practices:

- Spot check the work area to identify hazards.
- Establish and utilize a pathway which is most free of slip and trip hazards.
- Beware of slip hazards such as wet floors, slippery floors, and icy surfaces.
- Beware of uneven surfaces or terrain trip hazards.
- Carry only loads which you can see over.
- Keep work areas clean and free of clutter, especially in storage rooms and walkways.
- Communicate hazards to on-site personnel.
- Secure all loose clothing, ties, and remove jewelry while around machinery.
- Report and/or remove hazards.
- Keep safe buffer zones between workers using equipment and tools.

7.11 Electrical Hazards

No individual shall be permitted to work on any part of an electrical power circuit unless the person is protected against electric shock by de-energizing the circuit and grounding it, or by locking and tagging it out:

- All electrical wiring and equipment shall be intrinsically safe for use in potentially explosive environments and atmospheres.
- All electrical wiring and equipment shall be a type listed by Underwriters' Laboratories (UL) or Factory Mutual (FM) for the specific application.
- All installations shall comply with the National Electric Code (NEC) and the National Electric Safety Code (NESC).
- All electrical circuits shall be grounded according to NEC and NESC Code. Ground fault circuit interrupters shall be used in the absence of properly grounded circuitry or when portable tools must be used around wet areas.
- All live wiring or equipment shall be guarded to protect all persons or objects from harm.

7.12 Biological Hazards

Biological hazards include tick-borne diseases and poisonous plants.

7.12.1 Tick-borne Diseases

Lyme disease is caused by a bacterial parasite called spirochete, and is spread by infected ticks that live in and near wooded areas, tall grass, and brush. Once the tick deposits the spirochete, it must feed on the host blood for 12 to 24 hours before it can transmit the disease. The ticks that cause the disease in the Northeast and Midwest are often no bigger than a poppy seed or a comma in a newsprint. The peak months for human infection are June through October. There are many other tick borne diseases such as Rocky Mountain Spotted Fever which can be carried by a variety of ticks. The prevention and treatment of these diseases are similar to those of Lyme disease.

7.12.1.1 Prevention.

Ticks hang on blades of grass or shrubs waiting for a host to come by. When a host brushes against the vegetation, the tick grabs on. They typically climb onto an individual's legs and then crawl up looking to attach in a body crevice. Preventative measures include wearing light-colored clothing, keeping clothing buttoned, tucking pant legs into socks, pulling socks up past the knee, pulling the pant waist up above the naval area with a tight belt, and keeping shirt tails tucked in. Periodic checks for ticks should be made during the day, and especially at night. Hair should also be checked by parting it and combing through it to make sure that no ticks have attached to the scalp. Also, check clothing when it is first removed, before ticks have a chance to crawl off. It is common for ticks to be carried home on clothing and attach to others in the household.

The most common repellent recommended for ticks is N,N-dimethyl-m-toluamide, or DEET. It is important to follow the manufacturer's instructions found on the container for use with all insecticides especially those containing DEET. In general, DEET insect repellent should only be applied to clothing, not directly on the skin. Do not apply to sunburns, cuts or abrasions. Use soap and water to remove DEET once indoors.

7.12.1.2 Removal.

The best way to remove a tick is removal by tweezers. If tweezers are not available, cover your fingers (tissue paper) while grasping the tick. It is important to grasp the tick as close as possible to the site of attachment and use a firm steady pull to remove it. When removing the tick, be certain to remove all the mouth parts from your skin so as not to cause irritation or infection. Wash hands immediately after with soap and water, and apply antiseptic to the area where tick was removed.

7.12.1.3 Testing and Symptoms of Lyme Disease.

A variety of tests exist for determining Lyme Disease infection. However, most of these tests are not exact. The first symptoms of Lyme Disease usually appear from two days to a few weeks after a person is bitten by an infected tick. Symptoms usually consist of a ring-like red rash on the skin where the tick attached. The rash is often bull's eye-like with red on the outside and clear in the center. The rash may be warm, itchy, tender, and/or "doughy". Unfortunately, this rash appears in only 60 to 80 percent of infected persons. An infected person also has flu-like symptoms of fever, fatigue, chills, headaches, a stiff neck, and muscle aches and pains (especially knees). Rashes may be found some distance away from the site of actual attachment. These symptoms often disappear after a few weeks.

7.12.2 Poisonous Plants

Common Poison Ivy (Rhus radicans) grows as a small plant, a vine, and a shrub. Poison Ivy occurs in every state. The leaves always consist of three glossy leaflets. Poison Sumac (Rhus vernix) grows as a woody shrub or small tree 5 to 25 feet tall. It usually contains nine leaves, with eight paired leaves and one on top, and is common in swampy areas. The plants are potent sensitizers and can cause a mild to severe allergic reaction. This reaction is called contact dermatitis.

Dermatitis, in Rhus-sensitive persons, can result from contact with the milky sap found in the roots, stems, leaves, and fruit. The sap may retain its potency for months or years in a dry atmosphere, and can occur during any time of the year. The sap may also be carried by animals, equipment or apparel.

The best form of prevention is to avoid contact. This can occur by wearing long sleeves and gloves if necessary. Disposable clothing, such as Tyvek, is recommended in high risk areas to avoid exposure from contaminated apparel. Barrier creams and cleaners are also recommended.

7.12.3 Fire Prevention

All flammable and/or combustible liquids (i.e., gasoline) will be stored in approved safety containers that meet the specifications of National Fire Protection Association (NFPA) Code 30 and OSHA 29 CFR 1910.106(a)(29). Smoking or open flames are not permitted within 20 feet of any flammable liquid container.

All personnel performing work must be trained in the proper use of fire extinguishers. OSHA-approved, portable fire extinguishers will be located in every field vehicle. These extinguishers are rated for Class A (wood, paper), B (flammable liquid), and C (electrical) fires, and their locations are clearly identified with signs and/or labels. As required by 29 CFR 1910.157(d), at least one fire extinguisher with the appropriate rating must be located within 75 feet of a class A fire hazard and 50 feet of a Class B or C fire hazard.

7.13 Authorized Project Field Personnel

Only authorized project personnel will be granted access to active work areas during field activities. Authorized personnel may include designated representatives from FEI, subcontractors, Republic Services, the U.S. Environmental Protection Agency, and the Missouri Department of Natural Resources. A Log Book will be maintained onsite to record the personnel performing work at or visiting the Site.

7.14 Record Keeping and Reporting

The following records and/or logs will be maintained in the field vehicle of the Project Health and Safety Officer and will be available for inspection:

- This Health and Safety Plan;
- A Log Book that documents all personnel entering and exiting the Site;
- Accident Report Forms that document any accidents and/or injuries at the Site, including corrective actions; and
- Material Safety Data Sheets that provide health and safety and emergency response information on all chemicals and materials used at the site.

All accidents (including vehicular accidents while traveling to/from the Site), injuries, illnesses, chemical exposures, fires, and/or deviations from the HSP will be reported to the Project Health and Safety Officer and Project Manager. The Project Health and Safety Officer must complete an Accident Report Form for all accidents or injuries occurring at the Site. The accident or injury must be reported to the Project Manager and appropriate actions taken.

8 EMERGENCY CONTACTS, PROCEDURES AND CONTINGENCY PLAN

This section includes the telephone numbers for emergency contacts and the procedures to be implemented in the event of an emergency.

8.1 Emergency Contacts

In the event of an emergency related to field activities, notification of the appropriate contacts listed on Table 4 should be made.

8.2 Hospital Route

Should the need for emergency medical care arise, the closest medical facility is:

SSM DePaul Health Center
12303 DePaul Drive
St. Louis, MO 63044-2588

A hospital route map is included as Figure 3. Travel time to the hospital from the West Lake Landfill site is approximately 7 minutes. The direct route to SSM DePaul Health Center is as follows:

- Exit the landfill and head SE on St Charles Rock Road (MO 180) toward Taussig Ave;
- Turn Right at Mareschal Lane;
- Take a slight Left at DePaul Circle; and
- Turn Left to stay on DePaul Drive to the SSM DePaul Health Center.

8.3 Standard Emergency Procedures

The following standard emergency procedures will be used by onsite personnel. The Project Health and Safety Officer shall be notified of any onsite emergencies and be responsible for ensuring that the appropriate procedures are followed.

8.3.1.1 Pre Emergency Planning

The provisions of this section of the HSP will be discussed with onsite field personnel during the health and safety orientation meeting.

8.3.1.2 Personnel Injury in the Work Zone

Upon noticing any apparent serious injury, all work must be halted. The Project Health and Safety Officer should evaluate the nature of the injury. If the accident is deemed serious (i.e., bodily harm has occurred), an ambulance should be requested as the first action item.

8.3.1.3 Fire/Explosion

Proper storage of gasoline and other flammable liquids should be maintained to prevent or avoid spreading of a fire. Upon notification of a fire or explosion onsite, all site personnel should assemble at a designated meeting place and follow the directions below in Sections 8.7 and 8.8.

8.3.1.4 Other Equipment Failure

If any other equipment fails to operate properly, the Project Health and Safety Officer will be notified to evaluate the effect of this failure on continuing operations onsite. If the failure affects the safety of personnel or prevents completion of the work activities, all personnel will leave the work zone until the situation is evaluated and appropriate actions taken.

8.3.1.5 Site Re-entry

In all situations when an onsite emergency results in evacuation of the work zone, personnel will not re-enter until any of the following conditions have been met, as appropriate:

- The conditions resulting in the emergency have been corrected.
- The hazards have been reassessed by the Project Health and Safety Officer or a person designated by him.
- The HSP has been reviewed and revised, if necessary.
- Site personnel have been briefed on any changes in the HSP.

8.4 Location of Site Resources

The following items will be maintained in the field vehicle of the Project Health and Safety Officer used to support each field activity:

- A cellular telephone;
- A copy of this HSP;
- A Log Book;
- Monitoring instrument manuals,
- A copy of the hospital route map and emergency contact list;
- Fire extinguisher;
- Safety supplies, and
- Any other item deemed necessary for personnel health and safety.

8.5 Response Sequence for First Arrivals

If you are the first on the scene, respond as follows:

- Evacuate the incident area (if necessary). Remember that your safety must be the primary consideration;
- Restrict access to the incident area;
- Restrict the use of ignition sources for incidents involving flammable substances;
- Call the local emergency response organization or Project Health and Safety Officer. Report the following information:
    - Your name
    - Company affiliation
    - Telephone number from which you are calling
    - Location and type of incident
    - Injuries, if any, and the number and type of injuries
    - Details concerning the substances(s) involved (identification, amount, spill rate, size of area involved), if known
    - If a spill, the direction the spill is moving and the direction the wind may be dispersing airborne contaminants
    - Surficial material on which the spill occurred (i.e., asphalt, gravel, etc.)
    - Any first response action that has been taken
    - The time the incident occurred or when you discovered it
    - Any additional pertinent information
- Notify the Project Health and Safety Officer after the emergency response team has been contacted; and
- Coordinate with emergency response personnel when they arrive.

8.6 EMERGENCY RESPONSE FOR SEVERE WEATHER CONDITIONS

The Environmental Manager for Republic Services shall decide on the continuation or discontinuation of work based on current and pending weather conditions. Electrical storms, strong winds, and tornados are examples of conditions that would call for the discontinuation of work and evacuation of the site. No work will be permitted during any type of electrical storm. This section specifies what should be done in the event of a severe weather emergency, including electrical storms, high winds, heavy rain or hail, and tornados.

8.6.1 Electrical Storms

The procedures include the following:

- Seek shelter in the field vehicles;
- Do not stand near or under high objects.

8.6.2 High Winds

The procedures include the following:

- Seek shelter at the field vehicles;
- Do not drive high profile vehicles at high speeds;
- Park vehicles heading into the wind; and
- Wear safety goggles and a kerchief or dust mask covering your nose and mouth.

8.6.3 Heavy Rain or Hail

The procedures include the following:

- Seek shelter in the field vehicles; and
- Do not attempt to drive a vehicle if you are in an area that is or has the potential for flooding unless you are moving out of a low area.

8.6.4 Tornados

The procedures include the following:

- Seek shelter underground or in a closet, bathroom, or interior wall of a substantial building. Get under something sturdy and cover your head;
- Do not stay in a trailer or vehicle. Leave the trailer or vehicle and lie flat in the nearest ditch if substantial shelter is not available;
- Stay away from large areas of glass; and
- Stay away from large unsupported roofs.

8.7 Emergency Response for Fires

If a small fire occurs, extinguish it with the fire extinguisher in the field vehicle. Remember to follow these directions to put out the fire:

- Aim at the base of the flame;
- Use the appropriate type of fire extinguisher; and
- Remember that the spray only lasts a few seconds.

If a large fire occurs at the Site, follow these instructions:

- Move flammable and combustible items out of the path of the fire, if such action can be performed safely;
- Call the Fire Department and report the information outlined in Section 8.5;
- Do not attempt to put out a large fire with the field vehicle fire extinguisher;
- Report the incident to the On-site Health and Safety Officer and Project Manager.

8.8 Emergency Response for Explosions

If an explosion occurs, follow these instructions:

- Evacuate the site immediately;
- If feasible, decontaminate yourself and others;
- Do not address medical emergencies until you are out of danger;
- Call the Project Health and Safety Officer or local emergency response organization when you are out of danger to report the incident. Report the information outlined in Section 8.5.

9 REFERENCES

Feezor Engineering, Inc., (FEI), 2013a, “Bridgeton Landfill – West Lake Landfill Core Sampling Work Plan (Phases 1B, 1C and 2) Work Plan, prepared by Feezor Engineering, Inc., Engineering Management Support, Inc., and Auxier and Associates, Inc., December 18.

FEI, 2013b, “Bridgeton Landfill – West Lake Landfill Gamma Cone Penetration Test (GCPT) Work Plan Revision 2” prepared by Feezor Engineering, Inc., P.J. Carey and Associates, Engineering Management Support, Inc., and Auxier and Associates, Inc., September 27.

Herst & Associates, Inc., 2005, Remedial Investigation Report, West Lake Operable Unit 2, Bridgeton, Missouri, September 2005.

Nuclear Regulatory Commission (NRC), 1988, Radioactive Material in the West Lake Landfill – Summary Report, NUREG 1308 – Rev. 1, June

NRC, 1976, Office of Inspection and Enforcement, IE Inspection Report No. 76-01.

Radiation Management Corporation (RMC), 1982, Radiological Survey of the West Lake Landfill, St. Louis County, Missouri, NUREG/CR-2722, May.

Tables

Table 1 - Project Safety Personnel and Contact Information

Title	Company	Name	Mobile Telephone
Project Manager	FEI	Dan Feezor	(217) 836-8842
Project Health and Safety Officer	FEI	Paul Eastvold	(217) 691-6836
Project Radiation Safety Officer	Auxier & Associates	Mike Bollenbacher	(865) 414-0378
On-site Health and Safety Officer	Frontz Drilling (sonic drilling)	Jeremy Leckrone	(330) 466-3994
On-site Health and Safety Officer	ConeTech (GCPT drilling)	Rob Coates	(780) 908-1872
On-site Health and Safety Officer	Weaver Boos (surveying)	Collin Carson	(618) 792-3232
Environmental Manager (EM)	Republic Services	Brian Power	(618) 410-0157

Table 2 – Hazard and Control Matrix

Task	Potential Hazard	Control Measures
Driving Safety	• Vehicle traffic • Off-road Hazards (stationary objects, uneven terrain, etc) • Exposure to unfamiliar vehicle, streets, and/or directions • Changes in weather or traffic conditions	• Inspect car and maps before driving • Adjust mirrors and seat positions • Make sure luggage, supplies are secure • Wear seatbelt • Pull over to talk on cell phone • Listen to weather and traffic reports before leaving
Mobilize/Demobilize Equipment to Jobsite	• Insecure loads • Unsafe lifts • Blind spots	• Check load straps and chains after loading and before moving truck • Use spotter when backing vehicles or equipment • Notify workers in the area of planned equipment placement • Have workers move out of path if necessary when spotting equipment • Make eye contact and exchange signals with operator when moving near load • Use level, dry area to unload & store equipment and materials • PPE – Modified Level D, no coveralls required.
General Construction	• Caught between pinch points • Incorrect lifting techniques • Overexertion • Fall, same level • Heat Stress	• Use work gloves if pinch points could be a factor in unloading and loading supplies • Use proper bending/lifting techniques-use your legs, not your back • Ask for help if something is too heavy or uncomfortable to lift alone • Look before you step • Inspect ties for integrity • Take necessary breaks • Consume adequate amounts of fluids • Access pickup beds from the rear of the truck only • Do not jump into or out of pickup beds • PPE – Modified Level D, no coveralls required.

Table 2 – Hazard and Control Matrix (cont.)

Task	Potential Hazard	Control Measures
General Construction, continued	• Slipping and Tripping Hazards	• Travel directly to and from permitted work areas • Walking paths to be kept free of tripping hazards • Extension cords and hoses should be placed together and marked to increase awareness • Care to be taken when walking, especially on wet surfaces. • Use three point contact when getting on or off the equipment • Move equipment to dryer grounds if surface is muddy or has standing water
	• High Noise Levels	• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work periods) or when ever you must raise your voice for others to hear. (Double hearing protection when $\geq$ 90 dba)
	• Struck by/Against Heavy Equipment	• Wear reflective warning vests when exposed to vehicular traffic. • Isolate equipment swing areas • Make eye contact with operators before approaching equipment. • Understand and review hand signals • Warning vests, hard hat, safety glasses and steel toe work boots.
	• Use of Hand Tools	• All tools should be inspected prior to use • No damaged equipment should be used until repaired or replaced. • Damaged equipment must be tagged and taken out of service • Use the proper tool for the task • Know how to use tools safely • Utilize non spark tools around flammable chemicals

Table 2 – Hazard and Control Matrix (cont.)

Task	Potential Hazard	Control Measures
General Construction, continued	• Fueling of Vehicles	• Put vehicle in park or neutral with parking brake set • Turn off engine and remove key from ignition • Smoking is prohibited within 50 feet of fueling operations • Never leave the nozzle unattended. • Do not overfill vehicle tank or container • Never use a cell phone or other personal electronic device while refueling. • Upon exiting vehicle always touch a metal part of the vehicle away from the fill point before handling the nozzle to prevent static discharges.
	• Placing Fuel in Portable Containers	• Use only UL approved portable container with vapor -tight cap • When filling container, follow same rules as when fueling car: turn off engine; extinguish smoking materials, etc.… • Place portable fuel container on the ground during filling, and keep the metal nozzle spout in contact with the container to prevent build up and discharge of static electricity. Never fill a container in the bed of a pickup, in the back of a station wagon, or in the trunk of a car. • Manually control the nozzle valve throughout the filling process. Fill a portable container slowly to decrease the chance of static electricity buildup and minimize spilling or splattering. • Seal contain tightly before loading into vehicle • Secure container in an upright position to prevent sliding or tipping.
	• Horseplay	• Prohibit horseplay anywhere on jobsite • Review rules about horseplay with workers • Remind workers not to respond/participate in horseplay started by others
	• Chemical Exposure	• Avoid inhalation of vapors from fuel • Wash skin with soap and cool water if fuel contacts skin.

Table 2 – Hazard and Control Matrix (cont.)

Task	Potential Hazard	Control Measures
General Construction, continued	• Radiologically-impacted Areas 1 and 2	Untrained workers may not enter radiologically restricted area except during rescue operations. No other access to this area is allowed for any reason. Additional precautions for untrained workers working outside the radiologically restricted area include: • Wear gloves when disturbing or handling soil • No eating, drinking, smoking or using smokeless tobacco products within 50 feet of proposed fence line • Radiation workers may enter with proper preparation and monitoring.
Weather Conditions	• Evaluate prevailing weather conditions for the Site. • Contingency plans developed for likely severe weather conditions such as tornado, and extreme thunderstorm. • Provide for daily weather forecast service in extreme weather areas.	• Employees trained in contingency plan for severe weather conditions. • Weather service contacted regularly during storm conditions. • Supervisory personnel cease operations during extreme storm conditions, personnel evacuate to safe assembly area.
	• Heat Stress • Rain	• Workers are encouraged to increase fluid intake while working. • Workers will increase the frequency and duration of rest breaks while working in heat stress situations. • Workers will watch each other for signs and symptoms of heat exhaustion, fatigue. • If necessary, contractors will plan work in heat stress situations for early morning or evening during hot months. • Implement heat stress control program when necessary • Have proper rain gear available (i.e. Slickers, rubber boots, etc.)

Table 2 – Hazard and Control Matrix (cont.)

Task	Potential Hazard	Control Measures
Biological	• Injuries associated with insects, snakes, spiders and poisonous plants	• Be alert for signs of snakes, insect nests, ant hills and poisonous plants when walking. • Use extreme caution when moving or lifting objects that could be used by snakes or spiders as cover. Always wear leather gloves. • Never reach under or behind objects, or into other areas where snakes may hide. • Workers will tuck pants into socks and wear long sleeves and sturdy leather boots when walking in tall grass to protect against bio hazards. • Workers will use insect repellent when necessary. • Workers will use buddy system to check for signs of insect and spider bites, such as redness, swelling, and flu-like symptoms. • Workers will remove ticks immediately with fine tipped tweezers by grasping the tick as close to your skin as possible and gently pulling straight out. Do not squeeze the tick's body as this may inject fluids into you. Wash the bite area of skin and apply antiseptic. • Workers will immediately wash any areas that were exposed to poisonous plants. • Be aware that oil from poisonous plants can be carried on boots.

Table 3 - Hazard Assessment for Selected Constituents

Constituent	CAS No.	TLV (ppm)	STEL (ppm)	Toxic Route of Exposure	CARC	Comments
Methylene chloride	75-09-2	50	--	Vapor inhalation, skin absorption of liquid	CSH	Nonflammable; colorless; odorless; can't smell at <300 ppm
Tetrachloroethene	127-18-4	25	100	Vapor inhalation, skin absorption of liquid	CSH	Nonflammable; colorless; odorless; can't smell at <300 ppm
Toluene	108-88-3	50	150	Vapor inhalation, skin absorption of liquid	No	Flammable; colorless; sweet odor at <10 ppm
Xylenes	1330-20-7 (o-xylene)	100	150	Vapor inhalation, skin absorption of liquid	No	Flammable; colorless; sweet odor at <10 ppm
1,2-Dichloroethene	540-59-0	200	--	Vapor inhalation	No	Acrid odor
1,2-Dichloroethane	107-06-2	1	2	Vapor inhalation, skin absorption of liquid	CSH	Flammable; colorless; sweet odor at <10 ppm
Trichloroethene	79-01-6	50	100	Inhalation, skin absorption	CSA	Nonflammable; colorless; odorless; can't smell at <300 ppm
1,1-Dichloroethane	75-34-3	100	250	Vapor inhalation	No	Vapor
Chloroform	67-66-3	10	2*	Vapor inhalation	CSH	Flammable; colorless; sweet odor at <10 ppm
Vinyl chloride	75-01-4	1	5	Vapor inhalation	CH	No data
Acetone	67-64-1	250	1,000	Vapor inhalation, skin absorption of liquid	No	Flammable; sweet odor
1,1,2-Trichloroethane	79-00-5	10	--	Vapor inhalation, skin absorption of liquid	CSH	Combustible; colorless; sweet odor
Trans 1,2-DCE	540-59-0	200		Vapor inhalation, skin absorption of liquid	CSH	Flammable; colorless; pleasant odor
Cis 1,2-DCE	540-59-0	200		Vapor inhalation, skin absorption of liquid	CSH	Flammable; colorless; pleasant odor
1,1,1,-TCA	71-55-6	350		Irritant to eyes and tissue	No	Nonflammable; colorless
Carbon tetrachloride	56-23-5	5		Vapor inhalation, skin absorption of liquid	CSH	Noncombustible; colorless; sweetish odor
Methyl ethyl ketone	78-93-3	200		Vapor inhalation	No	Flammable; colorless; acetone-like odor
Vinyl acetate	108-05-4	10		Vapor inhalation, skin absorption of liquid	No	Flammable; colorless
Isopropyl alcohol	67-63-0	400		Vapor inhalation, skin absorption of liquid	No	Flammable; colorless; pleasant odor
Chromium	7440-47-3	0.5 mg/m^3		Inhalation; hexavalent chromium carcinogenic and corrosive on tissue	CH	

Notes: CAS No. = Chemical Abstracts Service Number
TLV = Threshold Limit Value; STEL = Short Term Exposure Limit
CARC = Carcinogenicity; CSH = Carcinogenicity suspected for humans; CH = Carcinogenicity established for humans; No = No definite carcinogenicity established.
ppm = parts per million; ug/m^3 and mg/m^3 = micrograms and milligrams per cubic meter, respectively.
-- = not listed in reference source.
* NIOSH (based on 60 minute exposure).
** According to 29 CFR 1910.1017, no employee may be exposed to vinyl chloride at a concentration greater than 5 ppm averaged over any period not exceeding 15 minutes, or 1 ppm over an 8-hour workday.

Table 4 - List of Emergency Telephone Contacts

Agency/Facility	Telephone No.	Contact
Police (Bridgeton Police Department)	911 Emergency (314) 739-7557 non-emergency	
Fire Department (Pattonville Fire Protection District)	911 Emergency (314) 291-6072 non-emergency	
Ambulance (Robertson Fire Protection District)	911	
Emergency Medical Facility/Hospital	(314) 344-6000	SSM DePaul Health Center 12303 DePaul Drive St. Louis, MO 63044-2588
Poison Control Center (Chemtrec)	(800) 424-9300	
Republic Services (On-site Representative and Environmental Manager)	(618) 410-0157 cell (314) 744-8165 office	Brian Power
Feezor Engineering, Inc.	(217) 836-8842 cell (217) 483-3118 office	Dan Feezor
Auxier & Associates (Radiological Health, Safety, and Risk Assessment)	(865) 414-0378 cell	Mike Bollenbacher
Frontz Drilling (Sonic Drilling)	(330) 466-3994 cell	Jeremy Leckrone
ConeTech (GCPT borings)	(780) 908-1872 cell	Rob Coates
Weaver Boos (Surveying)	(618) 792-3232 cell	Collin Carson

Figures

Source: MyTopo.com Date of Photograph 8/9/2007

0 600
SCALE IN FEET

N

Figure 1

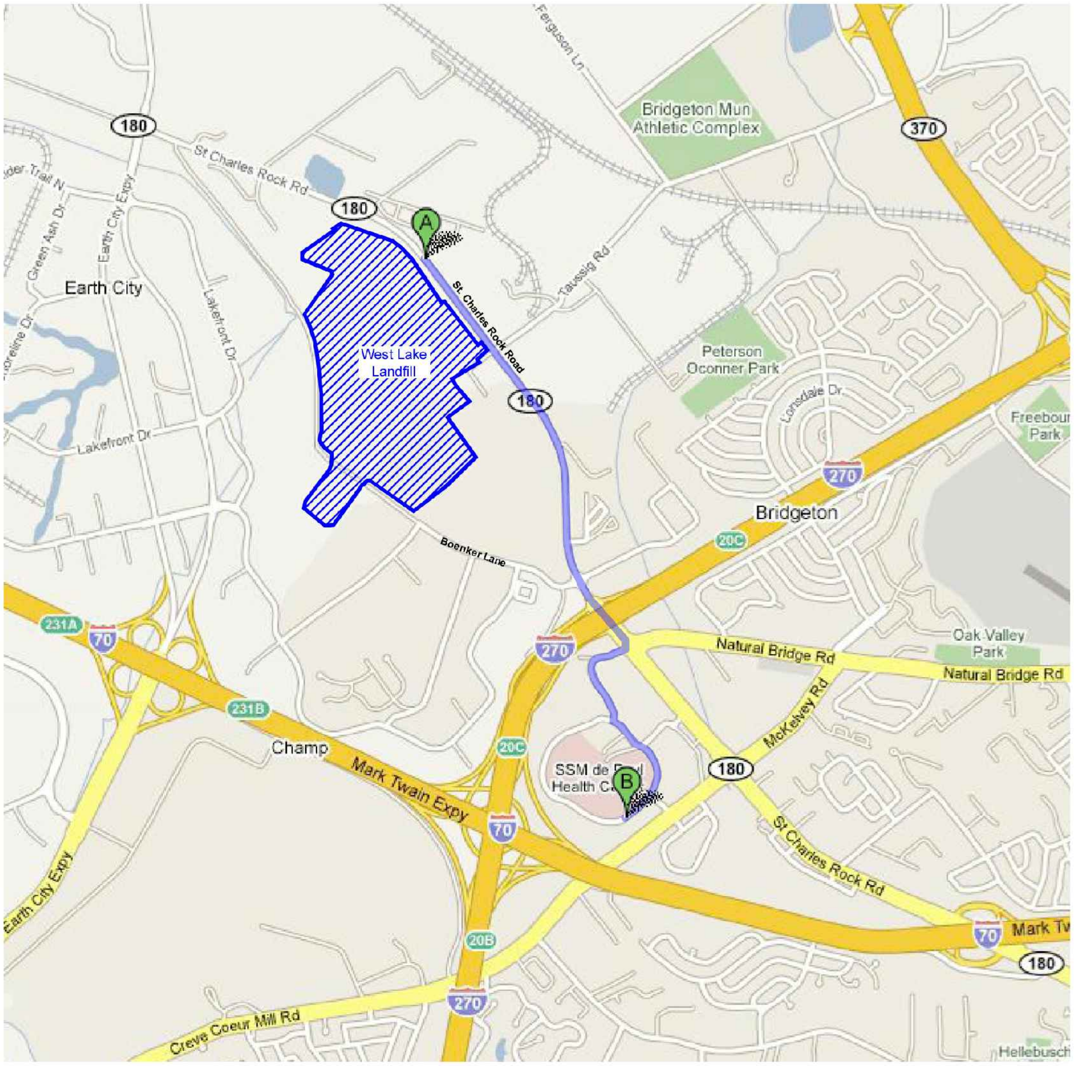
West Lake Landfill Features

Engineering for a Better World
FEEZOR ENGINEERING, INC.

M:\clients\EMSI\westlake\2013\Fencing\WL-Fig-1-Site Features-fl.dwg plotted: 12/18/2013

WEST LAKE LANDFILL 13570 ST. CHARLES ROCK ROAD BRIDGETON, MISSOURI 63044	WEST LAKE LANDFILL OU-1 AREA 1 RIM INVESTIGATION	Engineering for a Better World FEEZOR ENGINEERING, INC.	DECEMBER 2013 DESIGNED BY: PML APPROVED BY: DRF
PROPOSED PHASE 1B AND 1C BORING LOCATIONS			REVISION / DATE
PROJECT NUMBER: BT-012	FILE PATH:		DRAWING NO.: 2

Directions to 12303 De Paul Dr, Bridgeton, MO 63044
2.1 mi – about **7 mins**



13570 St Charles Rock Rd
Bridgeton, MO 63044

1. Head **southeast** on **MO-180/St Charles Rock Rd** toward **Taussig Ave** About 5 mins	go 1.3 mi	total 1.3 mi
2. Turn **right** at **Mareschal Ln**	go 0.1 mi	total 1.5 mi
3. Slight **left** at **De Paul Dr**	go 0.2 mi	total 1.7 mi
4. Turn **left** to stay on **De Paul Dr** Destination will be on the right About 2 mins	go 0.4 mi	total 2.1 mi

12303 De Paul Dr
Bridgeton, MO 63044

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Map data ©2008 Tele Atlas

N

NOT TO SCALE

Figure 3

Directions to Hospital from West Lake Landfill

FEEZOR ENGINEERING, INC. Engineering for a Better World

M:\clients\EMSI\westlake\2013\Fencing\WL-Fig-3-Hospital-Dir-fl.dwg plotted: 12/18/2013

Appendix A:

Forms/Logs

Health and Safety Compliance Agreement

I have read, understand, and agree to comply with the health and safety procedures in this Health and Safety Plan (HASP). In addition, I have attended, understand, and agree to comply with the information presented in the health and safety pre-activity meeting. I hereby agree that (1) compliance with the HASP is a condition of entry to the site, and (2) non-compliance with the HASP may result in work stoppage and/or dismissal from the Site.

Printed Name	Organization	Signature	Date

Personnel health and safety pre-activity meeting conducted by:

Name	Organization	Signature	Date

Accident/Incident Report

Date ________ Project Location ____

Description of accident/incident, including injuries, property damage, emergency action taken and personnel involved (use additional sheets if needed):

Witnesses of Accident/Incident:

Possible or known causes:

What actions are needed to prevent a similar incident?

______________________________ ______________________________
Reporter Project Health and Safety Officer

____
Project Manager

Appendix B:
Material Safety Data Sheets

Safety Data Sheet

Material Name: Diesel Fuel, All Types

SDS No. 9909
US GHS

Synonyms: Ultra Low Sulfur Diesel; Low Sulfur Diesel; No. 2 Diesel; Motor Vehicle Diesel Fuel; Non-Road Diesel Fuel; Locomotive/Marine Diesel Fuel

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

Phone: 732-750-6000 Corporate EHS
Emergency # 800-424-9300 CHEMTREC
www.hess.com (Environment, Health, Safety Internet Website)

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Flammable Liquids - Category 3
Skin Corrosion/Irritation – Category 2
Germ Cell Mutagenicity – Category 2
Carcinogenicity - Category 2
Specific Target Organ Toxicity (Single Exposure) - Category 3 (respiratory irritation, narcosis)
Aspiration Hazard – Category 1
Hazardous to the Aquatic Environment, Acute Hazard – Category 3

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

DANGER

Hazard Statements

Flammable liquid and vapor.
Causes skin irritation.
Suspected of causing genetic defects.
Suspected of causing cancer.
May cause respiratory irritation.
May cause drowsiness or dizziness.
May be fatal if swallowed and enters airways.
Harmful to aquatic life.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed.
Ground/bond container and receiving equipment.

Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Wear protective gloves/protective clothing/eye protection/face protection.
Wash hands and forearms thoroughly after handling.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Avoid breathing fume/mist/vapours/spray.

Response
In case of fire: Use water spray, fog or foam to extinguish.
IF ON SKIN (or hair): Wash with plenty of soap and water. Remove/Take off immediately all contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention.
IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a poison center/doctor if you feel unwell.
If swallowed: Immediately call a poison center or doctor. Do NOT induce vomiting.
IF exposed or concerned: Get medical advice/attention.

Storage
Store in a well-ventilated place. Keep cool.
Keep container tightly closed.
Store locked up.

Disposal
Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
68476-34-6	Fuels, diesel, no. 2	100
91-20-3	Naphthalene	<0.1

A complex mixture of hydrocarbons with carbon numbers in the range C9 and higher.

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

First Aid: Skin
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or with waterless hand cleanser. Obtain medical attention if irritation or redness develops. Thermal burns require immediate medical attention depending on the severity and the area of the body burned.

First Aid: Ingestion
DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, and other gaseous agents.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment. Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Caution, flammable vapors may accumulate in closed containers.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

Handle as a combustible liquid. Keep away from heat, sparks, excessive temperatures and open flame! No smoking or open flame in storage, use or handling areas. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents."

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks."

Incompatibilities

Keep away from strong oxidizers.

* * * Section 8 - Exposure Controls / Personal Protection * * *

Component Exposure Limits

Fuels, diesel, no. 2 (68476-34-6)

ACGIH: 100 mg/m3 TWA (inhalable fraction and vapor, as total hydrocarbons, listed under Diesel fuel)
Skin - potential significant contribution to overall exposure by the cutaneous route (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH:	10 ppm TWA
	15 ppm STEL
	Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA:	10 ppm TWA; 50 mg/m3 TWA
NIOSH:	10 ppm TWA; 50 mg/m3 TWA
	15 ppm STEL; 75 mg/m3 STEL

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile, neoprene, or PVC are recommended.

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

* * * Section 9 - Physical & Chemical Properties * * *

Appearance:	Clear, straw-yellow.	**Odor:**	Mild, petroleum distillate odor
Physical State:	Liquid	**pH:**	ND
Vapor Pressure:	0.009 psia @ 70 °F (21 °C)	**Vapor Density:**	>1.0
Boiling Point:	320 to 690 °F (160 to 366 °C)	**Melting Point:**	ND
Solubility (H2O):	Negligible	**Specific Gravity:**	0.83-0.876 @ 60°F (16°C)
Evaporation Rate:	Slow; varies with conditions	**VOC:**	ND
Percent Volatile:	100%	**Octanol/H2O Coeff.:**	ND
Flash Point:	>125 °F (>52 °C) minimum	**Flash Point Method:**	PMCC
Upper Flammability Limit (UFL):	7.5	**Lower Flammability Limit (LFL):**	0.6
Burning Rate:	ND	**Auto Ignition:**	494°F (257°C)

* * * Section 10 - Chemical Stability & Reactivity Information * * *

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

Incompatible Products

Keep away from strong oxidizers.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

* * * Section 11 - Toxicological Information * * *

Acute Toxicity

A: General Product Information

Harmful if swallowed.

B: Component Analysis - LD50/LC50

Naphthalene (91-20-3)

Inhalation LC50 Rat >340 mg/m3 1 h; Oral LD50 Rat 490 mg/kg; Dermal LD50 Rat >2500 mg/kg; Dermal LD50 Rabbit >20 g/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are repeatedly exposed.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

Contact with eyes may cause mild irritation.

Potential Health Effects: Ingestion

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Potential Health Effects: Inhalation

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This material has been positive in a mutagenicity study.

Carcinogenicity

A: General Product Information

Suspected of causing cancer.

Studies have shown that similar products produce skin tumors in laboratory animals following repeated applications without washing or removal. The significance of this finding to human exposure has not been determined. Other studies with active skin carcinogens have shown that washing the animal's skin with soap and water between applications reduced tumor formation.

B: Component Carcinogenicity

Fuels, diesel, no. 2 (68476-34-6)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans (listed under Diesel fuel)

Naphthalene (91-20-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
NTP: Reasonably Anticipated To Be A Human Carcinogen (Possible Select Carcinogen)
IARC: Monograph 82 [2002] (Group 2B (possibly carcinogenic to humans))

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

This product is not reported to have any specific target organ general toxicity repeat exposure effects.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

Fuels, diesel, no. 2 (68476-34-6)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	35 mg/L [flow-through]	

Naphthalene (91-20-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	5.74-6.44 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	1.6 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	0.91-2.82 mg/L [static]	
96 Hr LC50 Pimephales promelas	1.99 mg/L [static]	

96 Hr LC50 Lepomis macrochirus	31.0265 mg/L [static]
72 Hr EC50 Skeletonema costatum	0.4 mg/L
48 Hr LC50 Daphnia magna	2.16 mg/L
48 Hr EC50 Daphnia magna	1.96 mg/L [Flow through]
48 Hr EC50 Daphnia magna	1.09 - 3.4 mg/L [Static]

Persistence/Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

DOT Information

Shipping Name: Diesel Fuel

NA #: 1993 **Hazard Class:** 3 **Packing Group:** III

Placard:

* * * Section 15 - Regulatory Information * * *

Regulatory Information

Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Naphthalene (91-20-3)

CERCLA: 100 lb final RQ; 45.4 kg final RQ

SARA Section 311/312 – Hazard Classes

Acute Health	Chronic Health	Fire	Sudden Release of Pressure	Reactive
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product may contain listed chemicals below the de minimis levels which therefore are not subject to the supplier notification requirements of Section 313 of the Emergency Planning and Community Right- To-Know Act (EPCRA) of 1986 and of 40 CFR 372. If you may be required to report releases of chemicals listed in 40 CFR 372.28, you may contact Hess Corporate Safety if you require additional information regarding this product.

State Regulations

Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA	RI
Fuels, diesel, no. 2	68476-34-6	No	No	No	Yes	No	No
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	Yes	No

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.

Component Analysis - WHMIS IDL

No components are listed in the WHMIS IDL.

Additional Regulatory Information

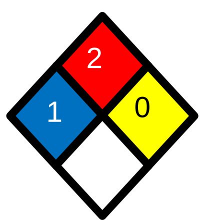
Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
Fuels, diesel, no. 2	68476-34-6	Yes	DSL	EINECS
Naphthalene	91-20-3	Yes	DSL	EINECS

* * * Section 16 - Other Information * * *

NFPA® Hazard Rating

Health 1
Fire 2
Reactivity 0



HMIS® Hazard Rating

Health 1* Slight
Fire 2 Moderate
Physical 0 Minimal
*Chronic

Key/Legend

ACGIH = American Conference of Governmental Industrial Hygienists; ADG = Australian Code for the Transport of Dangerous Goods by Road and Rail; ADR/RID = European Agreement of Dangerous Goods by Road/Rail; AS = Standards Australia; DFG = Deutsche Forschungsgemeinschaft; DOT = Department of Transportation; DSL = Domestic Substances List; EEC = European Economic Community; EINECS = European Inventory of Existing Commercial Chemical Substances; ELINCS = European List of Notified Chemical Substances; EU = European Union; HMIS = Hazardous Materials Identification System; IARC = International Agency for Research on Cancer; IMO = International Maritime Organization; IATA = International Air Transport Association; MAK = Maximum Concentration Value in the Workplace; NDSL = Non-Domestic Substances List; NFPA = National Fire Protection Association; NOHSC = National Occupational Health & Safety Commission; NTP = National Toxicology Program; STEL = Short-term Exposure Limit; TDG = Transportation of Dangerous Goods; TLV = Threshold Limit Value; TSCA = Toxic Substances Control Act; TWA = Time Weighted Average

Literature References

None

Other Information

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

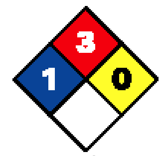
End of Sheet

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades **MSDS No. 9950**

EMERGENCY OVERVIEW
DANGER!
EXTREMELY FLAMMABLE - EYE AND MUCOUS MEMBRANE IRRITANT - EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF SWALLOWED - ASPIRATION HAZARD



NFPA 704 (Section 16)

High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.

Long-term exposure may cause effects to specific organs, such as to the liver, kidneys, blood, nervous system, and skin. Contains benzene, which can cause blood disease, including anemia and leukemia.

1. CHEMICAL PRODUCT and COMPANY INFORMATION (rev. Jan-04)

Amerada Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

EMERGENCY TELEPHONE NUMBER (24 hrs):	**CHEMTREC (800)424-9300**
COMPANY CONTACT (business hours):	Corporate Safety (732)750-6000
MSDS Internet Website	www.hess.com/about/environ.html

SYNONYMS: Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

See Section 16 for abbreviations and acronyms.

2. COMPOSITION and INFORMATION ON INGREDIENTS * (rev. Jan-04)

INGREDIENT NAME (CAS No.)	CONCENTRATION PERCENT BY WEIGHT
Gasoline (86290-81-5)	100
Benzene (71-43-2)	0.1 - 4.9 (0.1 - 1.3 reformulated gasoline)
n-Butane (106-97-8)	< 10
Ethyl Alcohol (Ethanol) (64-17-5)	0 - 10
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Tertiary-amyl methyl ether (TAME) (994-05-8)	0 to 17.2
Toluene (108-88-3)	1 - 25
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 - 15

A complex blend of petroleum-derived normal and branched-chain alkane, cycloalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol or MTBE and/or TAME). Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

3. HAZARDS IDENTIFICATION (rev. Dec-97)

EYES

Moderate irritant. Contact with liquid or vapor may cause irritation.

SKIN

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

INGESTION

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY

Contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with systemic toxicity. See also Section 11 - Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Chronic respiratory disease, liver or kidney dysfunction, or pre-existing central nervous system disorders may be aggravated by exposure.

4. FIRST AID MEASURES (rev. Dec-97)

EYES

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION

Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES (rev. Dec-97)

FLAMMABLE PROPERTIES:

FLASH POINT:	-45 ^{o}F (-43^{o}C)
AUTOIGNITION TEMPERATURE:	highly variable; > 530 ^{o}F (>280 ^{o}C)
OSHA/NFPA FLAMMABILITY CLASS:	1A (flammable liquid)
LOWER EXPLOSIVE LIMIT (%):	1.4%
UPPER EXPLOSIVE LIMIT (%):	7.6%

FIRE AND EXPLOSION HAZARDS

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

During certain times of the year and/or in certain geographical locations, gasoline may contain MTBE and/or TAME. Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration - refer to NFPA 11 "Low Expansion Foam - 1994 Edition."

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES (rev. Dec-97)

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE (rev. Dec-97)

HANDLING PRECAUTIONS

******USE ONLY AS A MOTOR FUEL******
******DO NOT SIPHON BY MOUTH******

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION (rev. Jan-04)

EXPOSURE LIMITS

Component (CAS No.)	Exposure Limits			
	Source	**TWA (ppm)**	**STEL (ppm)**	**Note**
Gasoline (86290-81-5)	ACGIH	300	500	A3
Benzene (71-43-2)	OSHA	1	5	Carcinogen
	ACGIH	0.5	2.5	A1, skin
	USCG	1	5	
n-Butane (106-97-8)	ACGIH	800	--	2003 NOIC: 1000 ppm (TWA) Aliphatic Hydrocarbon Gases Alkane (C1-C4)
Ethyl Alcohol (ethanol) (64-17-5)	OSHA	1000	--	
	ACGIH	1000	--	A4
Ethyl benzene (100-41-4)	OSHA	100	--	
	ACGIH	100	125	A3

Component (CAS No.)	Source	TWA (ppm)	STEL (ppm)	Exposure Limits Note
n-Hexane (110-54-3)	OSHA	500	--	
	ACGIH	50	--	skin
Methyl-tertiary butyl ether [MTBE] (1634-04-4)	ACGIH	50		A3
Tertiary-amyl methyl ether [TAME] (994-05-8)				None established
Toluene (108-88-3)	OSHA	200		Ceiling: 300 ppm; Peak: 500 ppm (10 min.)
	ACGIH	50	--	A4 (skin)
1,2,4- Trimethylbenzene (95-63-6)	ACGIH	25	--	
Xylene, mixed isomers (1330-20-7)	OSHA	100	--	
	ACGIH	100	150	A4

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of nitrile or neoprene are recommended. Chemical protective clothing such as that made of of E.I. DuPont Tychem ®, products or equivalent is recommended based on degree of exposure.

Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES (rev. Jan-04)

APPEARANCE

A translucent, straw-colored or light yellow liquid

ODOR

A strong, characteristic aromatic hydrocarbon odor. Oxygenated gasoline with MTBE and/or TAME may have a sweet, ether-like odor and is detectable at a lower concentration than non-oxygenated gasoline.

ODOR THRESHOLD

	Odor Detection	Odor Recognition
Non-oxygenated gasoline:	0.5 - 0.6 ppm	0.8 - 1.1 ppm
Gasoline with 15% MTBE:	0.2 - 0.3 ppm	0.4 - 0.7 ppm
Gasoline with 15% TAME:	0.1 ppm	0.2 ppm

BASIC PHYSICAL PROPERTIES

BOILING RANGE:	85 to 437 ^{o}F (39 to 200 ^{o}C)
VAPOR PRESSURE:	6.4 - 15 RVP @ 100 ^{o}F (38 ^{o}C) (275-475 mm Hg @ 68 ^{o}F (20 ^{o}C)
VAPOR DENSITY (air = 1):	AP 3 to 4
SPECIFIC GRAVITY (H_2O = 1):	0.70 – 0.78
EVAPORATION RATE:	10-11 (n-butyl acetate = 1)
PERCENT VOLATILES:	100 %

SOLUBILITY (H_2O): Non-oxygenated gasoline - negligible (< 0.1% @ 77 °F). Gasoline with 15% MTBE - slight (0.1 - 3% @ 77 °F); ethanol is readily soluble in water

10. STABILITY and REACTIVITY (rev. Dec-94)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources

INCOMPATIBLE MATERIALS

Keep away from strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

11. TOXICOLOGICAL PROPERTIES (rev. Dec-97)

ACUTE TOXICITY

Acute Dermal LD50 (rabbits): > 5 ml/kg
Acute Oral LD50 (rat): 18.75 ml/kg
Primary dermal irritation (rabbits): slightly irritating
Draize eye irritation (rabbits): non-irritating
Guinea pig sensitization: negative

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenicity: OSHA: NO IARC: YES - 2B NTP: NO ACGIH: YES (A3)

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

This product may contain methyl tertiary butyl ether (MTBE): animal and human health effects studies indicate that MTBE may cause eye, skin, and respiratory tract irritation, central nervous system depression and neurotoxicity. MTBE is classified as an animal carcinogen (A3) by the ACGIH.

12. ECOLOGICAL INFORMATION (rev. Jan-04)

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations. If released, oxygenates such as ethers and alcohols will be expected to exhibit fairly high mobility in soil, and therefore may leach into groundwater. The API (www.api.org) provides a number of useful references addressing petroleum and oxygenate contamination of groundwater.

13. DISPOSAL CONSIDERATIONS (rev. Dec-97)

Consult federal, state and local waste regulations to determine appropriate disposal options.

14. TRANSPORTATION INFORMATION (rev. Jan-04)

DOT PROPER SHIPPING NAME:	Gasoline	PLACARD:
DOT HAZARD CLASS and PACKING GROUP:	3, PG II	
DOT IDENTIFICATION NUMBER:	UN 1203	
DOT SHIPPING LABEL:	FLAMMABLE LIQUID	

15. REGULATORY INFORMATION (rev. Jan-04)

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a “petroleum exclusion” clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH	CHRONIC HEALTH	FIRE	SUDDEN RELEASE OF PRESSURE	REACTIVE
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION WT. PERCENT
Benzene (71-43-2)	0.1 to 4.9 (0.1 to 1.3 for reformulated gasoline)
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Toluene (108-88-3)	1 to 15
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 to 15

US EPA guidance documents (www.epa.gov/tri) for reporting Persistent Bioaccumulating Toxics (PBTs) indicate this product may contain the following deminimis levels of toxic chemicals subject to Section 313 reporting:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION - Parts per million (ppm) by weight
Polycyclic aromatic compounds (PACs)	17
Benzo (g,h,i) perylene (191-24-2)	2.55
Lead (7439-92-1)	0.079

CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 2 (Flammable Liquid)

Class D, Division 2A (Very toxic by other means) and Class D, Division 2B (Toxic by other means)

16. OTHER INFORMATION (rev. Jan-04)

NFPA® HAZARD RATING	HEALTH:	1	Slight
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
HMIS® HAZARD RATING	HEALTH:	1 *	Slight
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
	* CHRONIC		

SUPERSEDES MSDS DATED: 12/30/97

ABBREVIATIONS:

AP = Approximately	< = Less than	> = Greater than
N/A = Not Applicable	N/D = Not Determined	ppm = parts per million

ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute (212)642-4900
API	American Petroleum Institute (202)682-8000
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
DOT	U.S. Department of Transportation [General Info: (800)467-4922]
EPA	U.S. Environmental Protection Agency
HMIS	Hazardous Materials Information System
IARC	International Agency For Research On Cancer
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Association (617)770-3000
NIOSH	National Institute of Occupational Safety and Health
NOIC	Notice of Intended Change (proposed change to ACGIH TLV)
NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
OSHA	U.S. Occupational Safety & Health Administration
PEL	Permissible Exposure Limit (OSHA)
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit (NIOSH)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA	Self-Contained Breathing Apparatus
SPCC	Spill Prevention, Control, and Countermeasures
STEL	Short-Term Exposure Limit (generally 15 minutes)
TLV	Threshold Limit Value (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average (8 hr.)
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

Appendix C:
Standard Procedures for Monitoring for Radioactive Contamination

PROCEDURE 2.7
MONITORING PERSONNEL AND EQUIPMENT FOR RADIOACTIVE CONTAMINATION

1.0 PURPOSE

1.1 To describe the general approach for monitoring personnel and equipment for radioactive contamination.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Upon exiting potentially contaminated areas, monitoring of clothing and exposed skin surfaces will be performed. Equipment and materials will also be monitored and shown to be free of contamination before release for use without radiological restrictions or controls.

3.2 Equipment

3.2.1 Ratemeter-scaler: Model 3 or Model 2221, Ludlum Measurements, Inc.; or equivalent, equipped with audible speaker or headphones.

3.2.2 Detector: Selected detectors are indicated below. Equivalent detectors are also acceptable.

Activity	**Detector Type**	**Model**
Alpha	ZnS scintillator	Ludlum 43-1 or 43-5, Eberline AC3-7 or AC3-8
	Gas proportional	Ludlum 43-68, Ludlum 239-1
Beta	Gas proportional	Ludlum 43-68, Ludlum 239-1
	Geiger-Mueller	Ludlum 44-9, Eberline HP-260

3.2.3 Instrument cables

3.2.4 Check sources

3.2.5 Record Forms and/or field logbook

3.3 Quality Control Check

Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and source responses following Procedure 2.1.

3.4 Surface Scanning

3.4.1 Headphones or other audible signal operating modes are used for scanning.

3.4.2 Set the instrument response for "FAST", response where possible.

3.4.3 Pass the detector slowly over the surface. The detector should be kept as close to the surface as conditions allow. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor. While scanning for alpha or beta activity, the detector is typically moved about one detector width per second.

3.4.3 Note increases in count rate as indicated by the audible meter output. Identifiable increases in the audible response suggest possible contamination and should be resurveyed at a slower rate to confirm findings.

3.5 Personnel Monitoring

3.5.1 When monitoring for skin or clothing contamination, give particular attention to the hands, shoes, pant and shirt cuffs, knees, and other surfaces which have a high likelihood of contamination.

3.5.2 If there is detectable contamination, it should be removed as directed by the Health and Safety Committee (HSC) Chairperson. Decontamination guidance will be provided in the Survey Work Plan. The Site Safety Officer will implement decontamination or other contamination control actions at the project site.

3.6 Equipment Monitoring

3.6.1 For equipment surveys, attention should be given to monitoring cracks, openings, joints, and other areas where contamination might accumulate.

3.6.2 Measure levels of total and removable surface contamination (see Procedures 2.3 and 3.6) at locations of elevated direct radiation identified by the scan and at additional representative surface locations.

3.6.3 Acceptable surface contamination levels will be established on a project-specific basis, with details, including decontamination instructions, provided in the Survey Work Plan.

3.7 Document results of contamination surveys in field records

PROCEDURE 2.3
DIRECT RADIATION MEASUREMENT

1.0 PURPOSE

1.1 To describe the method for measuring total alpha and beta radiation levels on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Ratemeter-scaler: Model 3, Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent

3.1.2 Detector: Selected detectors are listed below: Equivalent detectors are also acceptable

Activity	Detector Type	Model
alpha	ZnS scintillator	Ludlum 43-1 or 43-5, Eberline AC3-7 or AC3-8
	gas proportional	Ludlum 43-68
beta	Geiger-Mueller	Ludlum 44-9, Eberline HP-260
	gas proportional	Ludlum 43-68

3.1.3 Cables

3.1.4 Check source

3.1.5 Record forms

3.2 Quality Control Check

3.2.1 Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and check source responses. Follow the procedures described in Procedure 2.1.

3.3 Direct Measurement

3.3.1 When applicable, team members performing instrument checks will calculate the average and maximum "field action levels" for instrument combination based on the specific site criteria and background.

Action level (cpm) = [site criteria (dpm/100 cm^2) x E x G x T] + B

T = count time (minutes)
E = operating efficiency (counts/disintegration)
G = geometry (total detector area (cm^2)/100)

	Total Area	Active Area
43-5 detector area =	80 cm^2	60 cm^2
43-1 detector area =	80 cm^2	50 cm^2
43-68 detector area =	126 cm^2	100 cm^2
44-9 detector area =	20 cm^2	15.5 cm^2
HP-260 detector area =	20 cm^2	15.5 cm^2

B = background (cpm)

A field count at or above this value indicates that further investigation in this location is necessary.

NOTE: For a particular site, the action level may be established as any activity exceeding background.

3.3.2 Select an appropriate counting time. A counting time is desired which will achieve a minimum detectable activity (see Procedure 4.2) value less than 50% of the applicable criteria. For most radionuclides a 1-minute count, using the instruments listed above, is adequate to achieve this sensitivity. For radionuclides having guidelines of 5000 dpm/100 cm^2, average and 15,000 dpm/100 cm^2, maximum, 0.5 minute counting times may be acceptable.

3.3.3 Place the detector face in contact with the surface to be surveyed. The detector face is typically constructed of a very thin and fragile material, so care must be exercised to avoid damage by rough surfaces or sharp objects. (Scans should have been performed, prior to this point, to identify representative locations and locations of elevated direct surface radiation for measurement.)

3.3.4 Set the meter timer switch, press the count-reset button, and accumulate the count events until the meter display indicates that the count cycle is complete.

3.3.5 Record the count and time on the appropriate record form.

3.3.6 If the location has a surface activity level above background, the area around the measurement locations should be scanned to determine the homogeneity of the measured activity level in the area. Dimensions and activity levels of inhomogeneities should be documented on the appropriate record form.

3.3.7 The surface activity may be calculated according to Procedure 4.3.

PROCEDURE 3.6
REMOVABLE ACTIVITY SAMPLING

1.0 PURPOSE

1.1 To provide guidelines for measuring removable alpha and beta radioactivity on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment and Materials

3.1.1 Smears, Mazlin wipes, filter papers (like Whatman 47 mm dia. glass fiber) or equivalent

3.1.2 Glassine or paper envelopes

3.1.3 Record forms

3.1.4 Counting equipment

3.2 Sample Collection

NOTE: Direct measurements will be completed before a smear sample is taken.

3.2.1 Grasp the smear (filter) paper by the edge, between the thumb and index finger.

3.2.2 Applying moderate pressure with two or three fingers, wipe the numbered side of the paper over approximately 100 cm^2 of the surface.

3.2.3 Place the filter in an envelope.

3.2.4. Record the smear number, site, date, location of the smear, and name of sample collector on the envelope.

3.2.5 Label and secure in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

3.2.6 If the direct measurement was elevated, the smear should be monitored (procedures 2.2 and 2.3) to determine whether contaminated material was transferred to the smear. If an activity level greater than 250 cpm is detected, the smear envelope should be marked as such.

NOTE: Smears having activity levels greater than 2500 cpm should be counted using field instrumentation. Decisions regarding further analyses and method of disposal of contaminated smears will be made by the PM and SSM on a case-by-case basis.

3.3 Field Sample Measurement

3.3.1 If the object of the survey is to determine if radon or thoron daughter products or other short half-life radionuclides are present, the smears should be counted within 1-2 hours before significant decay of short-lived radionuclides has occurred.

3.3.2 If necessary, smears can be counted in the field using portable instrumentation (see Procedure 2.3).

3.3.3 Record count and counting time data on the appropriate record form.

3.3.4 Subtract the background count (determined by counting blank or unused smear) and convert net count to dpm/100 cm^2, using proper time and detector efficiency values.

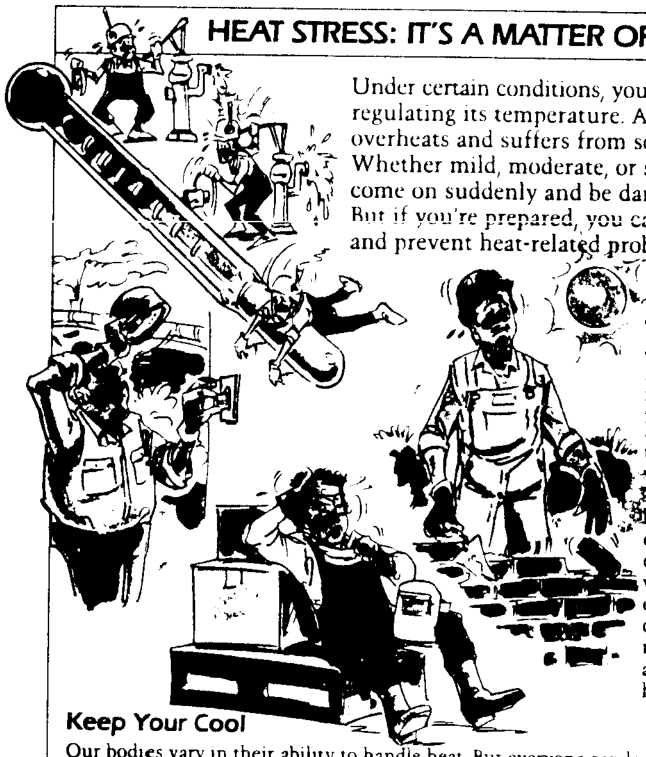
$$\frac{DPM}{100\,CM^2} = \left(\frac{NETCOUNT}{TIME(\mathrm{MIN}) * EFFICIENCY * \left(\frac{COUNT}{DISINTEGRATION} \right) * OTHERMODIFIYINGFACTORS} \right)$$

Appendix D:
Understanding and Preventing Heat Stress

UNDERSTANDING AND PREVENTING

HEAT STRESS

HEAT STRESS: IT'S A MATTER OF DEGREE



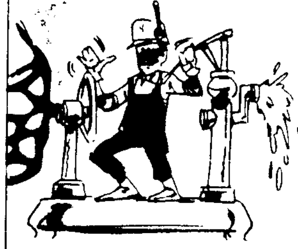
Under certain conditions, your body may have trouble regulating its temperature. As a result, your body overheats and suffers from some degree of heat stress. Whether mild, moderate, or severe, heat stress can come on suddenly and be dangerous to your health. But if you're prepared, you can "keep your cool" and prevent heat-related problems.

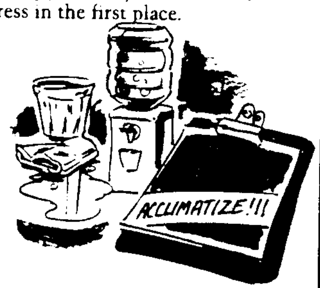
When It's Too Hot for You to Handle

Hard work or play can overload your body with extra heat—especially if you're active in a hot, humid, or poorly ventilated environment. These conditions make it harder for your body to handle heat—the sweat pours out, you don't feel well or work well, and you may feel dizzy or faint. If these signs of heat stress go unrecognized and untreated, serious—and sometimes permanent—health problems can occur.

Keep Your Cool

Our bodies vary in their ability to handle heat. But everyone can learn to avoid the adverse health and safety effects of heat stress. Keep your cool by knowing your body and its limitations, by understanding heat stress, and by preventing heat stress in the first place.





Know Your Body

Your body has a "heat regulator" that controls body temperature. But activity, heat, humidity, or lack of air movement can overwork this mechanism.

Understand Heat Stress

Protect yourself from heat stress. Learn to recognize warning signs—such as heavy sweating, fatigue, and dizziness—and know how heat stress is treated.

Prevent Heat Stress

Take an active role to prevent heat problems. Know the factors that increase your risk and take steps to reduce them, such as drinking water and acclimatizing to the heat.

This booklet is not intended to replace your company's health and safety policies or professional medical care.

HOW YOUR BODY HANDLES HEAT

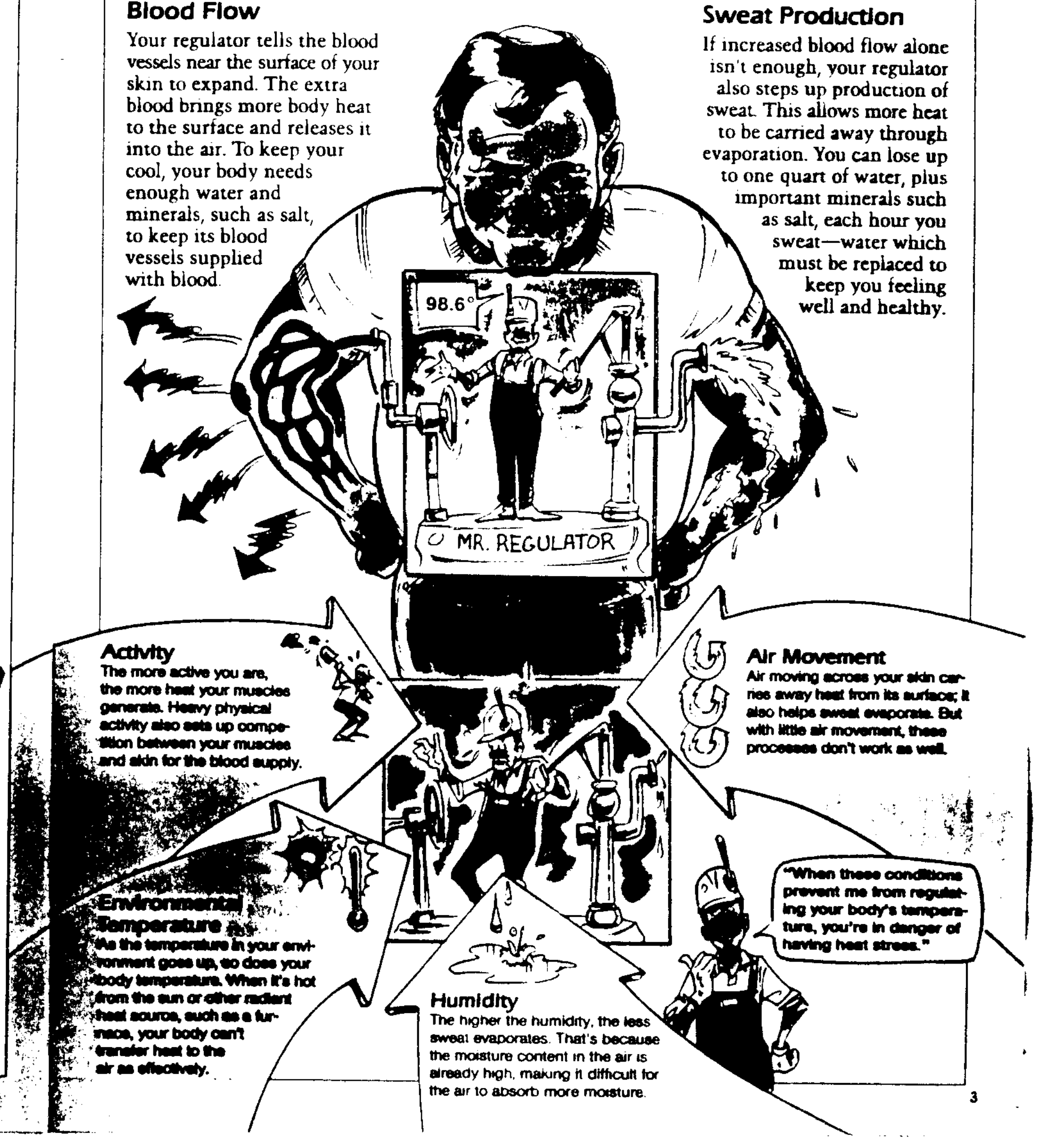
You have a natural mechanism that regulates the **core temperature** deep inside your body. You maintain a normal core temperature of 98.6° F by releasing excess heat into the air. The heat leaves your body through the blood vessels near the skin's surface and through the evaporation of sweat. Your level of activity and certain environmental conditions make the regulator work harder to increase your body's blood flow and sweat production.

Blood Flow

Your regulator tells the blood vessels near the surface of your skin to expand. The extra blood brings more body heat to the surface and releases it into the air. To keep your cool, your body needs enough water and minerals, such as salt, to keep its blood vessels supplied with blood.

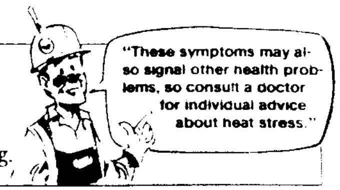
Sweat Production

If increased blood flow alone isn't enough, your regulator also steps up production of sweat. This allows more heat to be carried away through evaporation. You can lose up to one quart of water, plus important minerals such as salt, each hour you sweat—water which must be replaced to keep you feeling well and healthy.



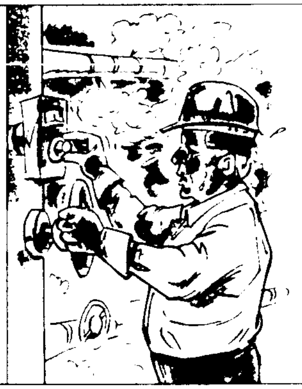
UNDERSTAND HEAT STRESS

When your body's heat regulator is pushed too far and your body overheats, some form of heat stress occurs. It may be mild, moderate, or severe; symptoms may range from excessive sweating to dizziness to unconsciousness. Since even severe heat stress can appear suddenly, learn the warning signs and how they're treated, so you can be more comfortable and productive, and prevent heat problems from occurring.



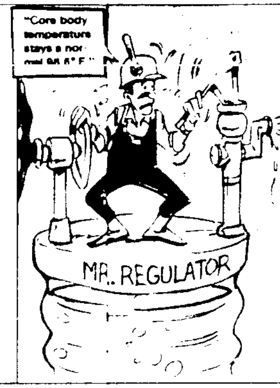
Mild: Minor Heat Problems

This is usually the earliest and least serious form of heat stress. Mild heat stress is always reversible and usually isn't dangerous unless the symptoms persist. Although you usually can continue work soon after treatment, always inform your supervisor if you have symptoms of mild heat stress.



Signs and Symptoms

You may have one or more of these symptoms.
- Excessive sweating.
- Painful spasms in muscles during or several hours after activity (**heat cramps**).
- Tiny red bumps on skin and a prickling sensation (**called prickly heat**).
- Irritability, mild dizziness, or weakness.



What's Going On

Sweating causes your body to lose too much water and minerals. This imbalance may cause muscles to cramp. Your sweat glands may become blocked and inflamed, causing a rash. Too little blood flowing to the brain causes irritability, dizziness and other symptoms.

Treatment

Follow this self-care.
- Rest in a cool or shady area.
- Drink water or other fluids.
- Use warm, moist compresses over cramping muscles, followed by gentle massage.
- Use a mild drying lotion to relieve the rash; keep skin dry and clean.

Taking additional salt is usually **not** necessary.

Signs and Symptoms

You may have one or more of these symptoms.
- Excessive sweating.
- Cold, moist, pale skin (or flushed skin).
- Thirst.
- Extreme weakness or fatigue.
- Headache, nausea, or loss of appetite.
- Dizziness or giddiness.
- A rapid, weak pulse.

What's Going On

Losing too much water and minerals reduces the blood supply to major organs, such as the brain, muscles, and skin. Your heart works harder to maintain the blood supply, straining your cardiovascular system. Some organs, such as the brain, may not get enough blood.

Treatment

You may need medical treatment, as well as this self-care:
- Rest in a cool or shady area.
- Drink water or other fluids.
- Take additional salt only if advised.
- Use cool compresses on forehead, around the neck, and under armpits.

Signs and Symptoms

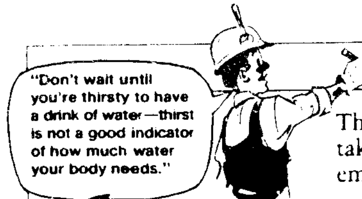
You may have one or more of these symptoms.
- Lack of sweating.
- Hot, dry, flushed skin.
- Deep, rapid breathing.
- A rapid, weak, and possibly irregular pulse.
- Headache, nausea.
- Dizziness, confusion, or delirium.
- Loss of consciousness.
- Convulsions.

What's Going On

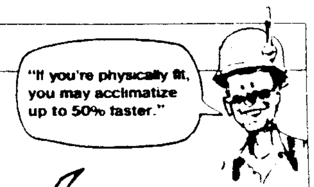
Your regulator becomes so overburdened that blood flow and sweat cannot cool your body enough. Your body becomes so overheated that sweat glands and other organs don't function normally. This can affect vital organs, including your heart and brain, and may cause permanent damage.

Treatment

Call for medical help right away. While waiting for medical treatment, begin first aid:
- Rest in a cool or shady area.
- Remove outer clothing.
- Lower body temperature with cool compresses, increasing air movement, or both.
- Drink water or other fluids (if conscious).



CHECKPOINTS FOR PREVENTING HEAT STRESS



There are several steps you and your employer can take to prevent heat stress. Both supervisors and employees can recognize risks and follow safety procedures to reduce them. Be sure to inform your employer about any medical conditions you have and discuss whether you might be at increased risk.

Know Your Environment

Your company controls the work environment so it's safe. You can help by knowing which factors increase your risk of heat stress. Talk with your supervisor about ways to reduce them, so you can take special precautions to protect yourself when the risk is especially high, such as on hot, humid days.

Drink Plenty of Water

Increase the water you drink to replenish the water you lose from sweating. Drink more than you need to satisfy your thirst. It's best to replenish regularly by drinking small amounts frequently throughout the day. You may need to drink a glass of water or more every hour.

Take Appropriate Breaks

Whether you need rest breaks depends on conditions such as air temperature, sun exposure, and how hard you're working. Your company monitors these conditions and establishes a safe work/rest regimen for you and your coworkers.

Wear Proper Clothing

Your employer supplies you with heat-protective clothing and equipment, such as heat shields, if needed. When possible, wear loose, lightweight clothing, which encourages heat to be released.

Acclimatize Yourself

Your employer may give you guidelines to help you adapt to the heat. This natural process, called **acclimatization,** takes about 7 to 10 days. It usually consists of short periods of working in the heat, which gradually increase in time and intensity. If you spend time out of the heat due to vacation or reassignment, you may need to acclimatize yourself again.

Stay in Good Shape

Conditioned muscles work more efficiently and generate less body heat, while extra body weight makes you work harder. People in good condition tend to acclimatize better because their cardiovascular systems respond better.

Eat Wisely

Hot, heavy meals add heat to your body and divert blood to your digestive system so eat lightly during your workday. Remember, too, a normal diet usually supplies all the salt you need to replace the salt lost through sweating.

Know Special Risks

Alcohol (including beer), **caffeine, medications** such as those used to control high blood pressure or allergies, **medical conditions** including diabetes, **recent illnesses** such as flu, and increasing **age** all increase your risk of heat stress.

"TEAMWORK HELPS YOU BEAT THE HEAT"

In many jobs, heat is a fact of life. Since too much heat can be harmful to your health and be a safety problem, your company wants to help you reduce the risk of heat stress by monitoring and controlling the work environment. Be sure to follow company procedures, such as adjusting gradually to working in the heat and drinking plenty of water. You'll feel better on and off the job knowing what heat stress is and how to prevent it.

KRAMES
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